

**Basic Psychological Needs as mediators: An examination of the relationship between  
exercise and well-being**

Lindsay S. Meldrum, BA

Submitted in partial fulfillment of the requirements for the degree of  
Master of Arts in Applied Health Sciences  
(Health and Physical Education)

Supervisor: Philip Wilson, PhD

Faculty of Applied Health Sciences, Brock University  
St. Catharines, Ontario

Lindsay Meldrum © August 2013

## Acknowledgements

Phil, thank you for everything you have done for me over the past two years. While you were largely ‘on paper’, you contributed a significant amount of time to helping me develop as a researcher and were always willing to listen and offer advice. The conferences you sent me to were both great academic experiences as well as great life experiences I wouldn’t have had otherwise, thank you.

Diane, I will forever be grateful for all that you have done for me. I can’t thank you enough for the countless hours you have devoted to me and my research. The decision to do my masters with you was one of my best. You have opened so many doors for me, and because of all that you have done I know that more doors will continue to open. Your commitment to your students is incredible. I am so fortunate to have worked with you, and to call you a friend.

To Dr. Jae Patterson, thank you for your insightful comments and suggestions. Thank you to Dr. Shauna Burke for serving as my external examiner, and offering suggestions that strengthened my document.

To my family, thank you for your unconditional support and encouragement, and for always being there for me. Thank you Karen and Jeff, for always being excited for me and encouraging me.

Matt, I’m so happy we were in this together and able to have fun along the way. I couldn’t (wouldn’t) have done it without you. Time for the real world... and I’m so excited about what comes next for us.

## Abstract

Grounded in Basic Psychological Needs Theory (Deci & Ryan, 2002), the present investigation examined whether psychological need satisfaction mediated the relationship between moderate-to-vigorous physical activity (MVPA) and well-being. Adopting a longitudinal design participants ( $N = 147$ ) completed questionnaires assessing MVPA, well-being and perceived psychological need satisfaction in exercise contexts on three occasions separated by three weeks. A pattern of small-to-moderate correlations were noted between MVPA and indices of well-being ( $r_{12}$ 's ranged from .16 to .29). Multiple mediation analysis indicated that perceived psychological need satisfaction mediated the relationship between MVPA and well-being with perceived competence emerging as a unique mediator. Serial mediation analyses indicated the importance of ongoing psychological need satisfaction to well-being. Contexts that afford individuals the opportunity to engage in MVPA, as well as supports their need for competence, would be most advantageous for the promotion of psychological well-being.

## **Table of Contents**

### **Chapter 1: Literature Review**

Introduction	1
Exercise Defined	2
Well-Being Defined	4
Hedonic Well-Being	4
Eudaimonic Well-being	5
Physical Self-Concept	6
Exploring the Exercise – Well-being Relationship	7
Importance of Theory to Informing Health Research	9
Self-Determination Theory	10
Basic Psychological Needs Theory	11
Basic Psychological Needs Theory and Exercise	
Research	12
Research Questions	15
Significance of Proposed Research	16

### **Chapter 2: Methods**

Participants	17
Instruments	18
Demographics	18
Eudaimonic Well-Being	18
Hedonic Well-Being	19
Physical Self-Concept	20
Leisure Time Physical Activity	20
Perceived Exertion	22

Psychological Need Satisfaction	22
Procedures	23
Analysis	24
<b>Chapter Three: Results</b>	
Preliminary Data Analysis	27
Sample Characteristics	28
Descriptive Statistics and Estimates of Internal Consistency	28
Patterns of association between study variables (Cross sectional)	29
Patterns of association between study variables (Change scores)	30
Main Analyses	31
Multiple Mediation	31
Serial Mediation	32
<b>Chapter Four: Discussion</b>	
Discussion	33
Comparison of Study Participants to Previous Research	34
MVPA and Well-Being	35
Association of Psychological Need Satisfaction with Behaviour and Well-being	37
Does Psychological Need Fulfillment Mediate the MVPA – Well-being Relationship?	39
Limitations	43
Future Directions	46
Practical Implications	49

Conclusion	51
<b>References</b>	52
<b>Notes</b>	71
<b>Appendices</b>	
Appendix A: Research Ethics Clearance	86
Appendix B: Instructor Recruitment Script	87
Appendix C: Recruitment Script	88
Appendix D: Reminder Script	89
Appendix E: Letter of Invitation	90
Appendix F: Questionnaires	92
Appendix G: Informed Consent	100
Appendix H: Debriefing Form	102

## Tables

Table 1. Time 1 Demographic Descriptive Statistics	72
Table 2. Time 1 Study Variable Descriptive Statistics	73
Table 3. Time 2 Study Variable Descriptive Statistics	74
Table 4. Time 3 Study Variable Descriptive Statistics	75
Table 5. Pearson Bivariate Correlations between Study Variables at Time 1	76
Table 6. Pearson Bivariate Correlations between Study Variables at Time 2	77
Table 7. Pearson Bivariate Correlations between Study Variables at Time 3	78
Table 8. Pearson Bivariate Correlations between Change Scores for Study Variables at Time 1 – Time 2	79
Table 9. Pearson Bivariate Correlations between Change Scores for Study Variables at Time 1 – Time 3	80
Table 10. Pearson Bivariate Correlations between Change Scores for Study Variables at Time 2 – Time 3	81
Table 11. Bootstrapped Indirect Effects of Change in MVPA (Time 1) on Changes in Well- and Ill-Being (Time 2) Through Psychological Need Satisfaction (Time 1)	82
Table 12. Bootstrapped Indirect Effects of Change in MVPA (Time 1) on Changes in Well- and Ill-Being (Time 3) Through Psychological Need Satisfaction (Time 1)	83

Table 13. Bootstrapped Indirect Effects of Change in MVPA (Time 2) on Changes in Well- and Ill-Being (Time 3) Through Psychological Need Satisfaction (Time 2)	84
Table 14. Path Coefficients from Models Estimated Using PROCESS	85



**Figures**

Figure 1. Serial Multiple Mediation Model .....	32
---	----

## Basic Psychological Needs as mediators: An examination of the relationship between exercise and well-being

### **Introduction**

Well-being has been advocated as an important aspect of health (World Health Organization, 2012) and vital to living a full and pleasant life. As such, the promotion of well-being through the development of policy has become a major public health agenda (e.g., Diener, Lucas, Schimmack, & Helliwell, 2009). Well-being has been conceptualized as “a dynamic and relative state where one maximizes his or her physical, mental, and social functioning in the context of supportive environments to live a full, satisfying, and productive life” (Kobau, Sneizek, & Zack, 2009, p. 4). With much of the extant knowledge of the determinants of well-being centered on heritable and/or stable factors (Lykken & Tellegen, 1996; McCrae & Costa, 1990), Sheldon and Lyubomirsky (2004) have advocated for an increased understanding of modifiable factors (e.g., activities engaged in) to elucidate factors associated with the promotion of well-being.

Physical activity is a modifiable factor that has been advocated as one means through which well-being can be achieved or enhanced (e.g., Biddle & Ekkekakis, 2005; Bouchard, Blair, & Haskell, 2007; Fox & Wilson, 2008). Despite known benefits of engaging in a physically active lifestyle, accelerometry data from the 2007-2009 Canadian Health Measures Survey (CHMS) indicates that only 17.4 percent of Canadian adults (aged 20-39) were meeting physical activity recommendations (Colley, Garriguet, Janssen, Craig, Clarke, & Tremblay, 2011). Exercise, a form of physical activity, is one avenue through which individuals can increase activity levels and achieve health benefits (Bouchard, Blair, & Haskell, 2007). Research employing both cross-sectional (e.g.,

Edmunds, Ntoumanis, & Duda, 2006) and longitudinal designs (e.g. Wilson, Longley, Muon, Rodgers, & Murray, 2006) provides support for the relationship between exercise and increased well-being. While the association between exercise and well-being is well established (e.g., Ekkekakis & Backhouse, 2009; Mack, Wilson, Gunnell, Gilchrist, Kowalski, & Crocker, 2012), less is known about the process through which exercise influences well-being. Stated another way, research testing the extent to which the exercise and well-being relationship is mediated by psychological need satisfaction is in its infancy. As such, the processes through which exercise may be associated with well-being outcomes over time is deserving of further attention (e.g., Mack et al., 2012).

### **Exercise Defined**

Physical activity is advocated for the promotion of both physical and mental health (e.g., Bouchard et al., 2007; Penedo & Dahn, 2005). In regards to psychological health and well-being, evidence suggests that physical activity both increases well-being (e.g., vitality and satisfaction with life; Ekkekakis & Backhouse, 2009; Mack et al, 2012; Vuillemin et al., 2005) and decreases ill-being (i.e., depression and anxiety; Barbour, Edenfield, & Blumenthal, 2007; Martinsen, 2008).

Exercise is a form of physical activity, conceptualized as structured and deliberate activities involving repeated bodily movements, designed to maintain or improve physical fitness (Bouchard et al., 2007). By definition the study of the benefits of structured exercise excludes physical activity accrued in occupational settings, while commuting, or engaging in household tasks (i.e., health-enhancing physical activity). When considering how much exercise is sufficient to promote and protect health, several criteria (i.e., mode, frequency, duration, and intensity) are often considered. While all

exercise criteria should be considered when prescribing exercise, one dimension – notably intensity – has been deemed critical (American College of Sports Medicine, 2006). Intensity is typically categorized as either mild, moderate, or vigorous (Godin & Shephard, 1997). Mild-intensity exercise is that which involves minimal effort, and does not cause the individual to feel winded (Bouchard et al., 2007). Exercise that leaves the individual feeling slightly warm and winded is considered moderate-intensity, while exercise that requires great effort and results in rapid breathing and a significant increase in heart rate is considered to be vigorous-intensity (Bouchard et al., 2007). While activities engaged in at a mild intensity do provide some health benefits, especially in comparison to being sedentary (Hamer, Stamatakis, & Steptoe, 2009), there is mounting evidence suggesting that the greatest health benefits occur when exercise is performed at a moderate-to-vigorous intensity (e.g., Canadian Society for Exercise Physiology [CSEP]; 2012; Godin, 2011; Warburton, Nicol, & Bredin, 2006; WHO, 2012).

Drawing on research examining factors associated with ill-being, it appears that exercise intensity (not frequency or duration), is associated with a reduction in depressive symptoms (Craft & Landers, 1998; Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005). Additionally, research (e.g., Cerin, Leslie, Sugiyama, & Owen, 2009; Molina-García, Castillo, & Queral, 2011) suggests that intensity of leisure time physical activity uniquely predicts markers of well-being. In other words, the strength of the relationship between exercise and markers of well-being differs depending on intensity. The exercise intensity – well-being relationship is particularly evident when the intensity is self-selected as opposed to when it is determined by the researcher (Ekkekakis, Parfitt, & Petruzzello, 2011). Building on physical activity recommendations (e.g., CSEP, 2012),

combined with research demonstrating the unique role of intensity (e.g., Cerin et al., 2009) the present study will examine the relationship between well-being and moderate-to-vigorous physical activity (MVPA).

### **Well-Being Defined**

Understanding the concept of well-being is complex, with various views offered in regards to the definitions, contents, as well as the processes through which it can be attained (Ryan & Deci, 2001). Within the broad scope of well-being research lays two distinct philosophies of thought. Aristippus's view that well-being is the maximization of pleasure is aligned with a hedonic approach to well-being (Ryan & Deci, 2001). Alternatively, Aristotle conceptualized happiness as self-actualization and living with virtue, which aligns with the eudaimonic philosophy (Ryan & Deci, 2001). While hedonic and eudaimonic well-being are related, it is argued that they represent distinct facets (e.g., Ryan & Deci, 2001). With researchers often subscribing to a single view, both the hedonic and eudaimonic approach have been furthered through distinct lines of research.

**Hedonic well-being.** The hedonic philosophy of well-being envelops the idea that well-being consists of pleasure or happiness (Ryan & Deci, 2001). Hedonic psychologists posit that well-being consists of subjective happiness and the experience of pleasure versus displeasure through all facets of life (Kahneman, Diener, & Schwarz, 1999). The pleasure/displeasure of human experience is most often assessed via cognitive and affective judgments of subjective well-being (SWB; Diener, 1984; Kesebir & Diener, 2008) specifically consisting of three factors: life satisfaction, the presence of positive affect, and the absence of negative affect (Ryan & Deci, 2001).

While well-being may be universal, there are many individual differences in regards to how it is experienced. Research has established personality factors as a dominant predictor of SWB (Kesebir & Diener, 2008) accounting for 39 percent of the total variance (Steel, Schmidt, & Shultz, 2008). Specifically, personality traits such as extraversion and agreeableness are positively associated with SWB (Ryan & Deci, 2001). In addition to personality factors SWB has been correlated with a variety of socio-demographic and health factors (Kesebir & Diener, 2008) including age (i.e. being older) and marital status (i.e. being married; Diener & Suh, 1998; Kesebir & Diener, 2008). Greater wealth has been associated with higher SWB, however a threshold is present where beyond a certain point greater wealth is no longer associated with an increase in well-being (Kesebir & Diener, 2008). Finally, intentional activities (i.e., actions engaged in by an individual that requires effort) has also been linked to increased well-being (Lyubomirsky, Sheldon, & Schkade, 2005; Sheldon & Lyubomirsky, 2006). As such, while certain aspects of well-being are stable, other dimensions are under our control and individuals are considered active agents in the process of increasing well-being through actions and activities.

**Eudaimonic well-being.** The eudaimonic philosophy of well-being portrays human nature as an active process whereby individuals seek opportunity for personal growth, flourishing and the maximization of one's potential, as opposed to happiness per se (Ryan & Deci, 2001). Eudaimonic well-being involves the experience of pleasure, but emphasizes a more enduring form of well-being based on how meaningful one's life feels in addition to how good it feels (Huta, in press). Subjective vitality is defined as "one's conscious experience of possessing energy and aliveness" (Ryan & Frederick, 1997, p.

530) and has been advocated has one marker of well-being consistent with eudaimonic philosophy (Lundqvist, 2011).

Both the determinants and correlates of eudaimonic well-being generally mirror known factors influencing hedonic markers. Schmutte and Ryff (1997) state that both neuroticism and extraversion are personality traits that consistently predict eudaimonic well-being. Various socio-demographic factors have been demonstrated to correlate with eudaimonic well-being including age and education (Ryff & Singer, 1988). Income has been demonstrated to have only a minimal relationship with indices of eudaimonic well-being (Triado, Villar, Sole, & Celdran, 2007). Engagement in select activities (e.g., counting one's blessings, displaying kindness) has also been linked to increased eudaimonic well-being, highlighting the dynamic nature of this construct (Emmons & McCullough, 2003; Huta & Ryan, 2010).

**Physical Self-Concept.** Self-esteem has been identified as an essential element of psychological well-being given its consistent association with adaptive outcomes (Fox & Wilson, 2008; Leary & Tangney, 2003; Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004). Research has suggested that self-esteem is resilient to change (Swann, 1996) and the outcome (as opposed to the cause) of doing well (Baumeister, Campbell, Krueger, & Vohs, 2003). Consequently, research in physical activity contexts has been directed towards the role of the physical self as the process of developing and maintaining self-esteem (Fox & Wilson, 2008). In their seminal work, Shavelson, Hubner, and Stanton (1976) defined self-concept as a person's self-perceptions formed from experience with, and interpretations of, one's environment. Organized hierarchically, self-concept is a multifaceted construct emphasizing multiple relatively

distinct components. Physical self-concept is a subset of general self-concept, along with components such as academic self-concept and social self-concept (Marsh, 1990b). Various viewpoints have emerged over time concerning the facets of physical self-concept, with no consensus reached. Fox (1990) contends that physical self-concept is comprised of four facets (sport, condition, body and strength) while Marsh (1990a) contends that there are in fact eight facets (Strength, Body Fat, Activity, Endurance/Fitness, Sports Competence, Coordination, Health, Appearance, Flexibility). An additional line of inquiry views physical self-concept as being comprised of two more general facets (i.e., physical ability and physical appearance) which are informed by perceptions of behaviour in specific situations (Shavelson et al., 1976). Therefore, how an individual perceives his/her ability to accomplish physical tasks and how fit they perceive their body to be contributes to their overall sense of self.

### **Exploring the Physical Activity – Well-being Relationship**

A consistent link has been noted between greater engagement in physical activity (and exercise) and higher levels of well-being (e.g., Biddle & Ekkekakis, 2005; Blacklock, Rhodes, & Brown, 2007; Ekkekakis & Backhouse, 2009; Netz, Wu, Becker, & Tenenbaum, 2005; Vuillemin et al., 2005; Wendel-Vos, Schuit, Tijhuis, & Kromhout, 2004), however closer inspection of the literature suggests that the nature of the well-being – physical activity relationship may be more complex depending on the instrument used to assess well-being.

Research examining markers of hedonic well-being provides differential support in relation to indices of physical activity. The relationship between physical activity and positive affect has consistently been supported within both cross-sectional (e.g., Ozetkin



& Tezer, 2009; Pasco, Jacka, Williams, Brennan, Leslie, & Berk, 2011) and longitudinal research (e.g., Mack et al., 2012). However, the relationship between negative affect and physical activity appears to be negligible (e.g. Wilson, Mack, Blanchard, & Gray, 2009; Mack et al., 2012). Cross-sectional research demonstrates that physical activity does not appear to be a significant predictor of negative affect (Ozetkin & Tezer, 2009). Research employing a longitudinal design demonstrates a weak relationship between physical activity and negative affect across two time points, with increase in physical activity across a 6-month period only minimally correlated with lower negative affect (Mack et al., 2012).

In regards to eudaimonic well-being, research supports the relationship between markers of eudaimonic well-being (i.e., subjective vitality) and physical activity (e.g., Molina-García et al., 2011; Wilson et al., 2006). Of particular relevance is the finding that the subjective vitality – exercise behaviour relationship appears to be influenced most strongly by the intensity of engagement (Molina-García et al., 2011; Vlachopoulos, Ntoumanis, & Smith, 2010). When considered over time, participant perceptions of vitality decreased as a result of engagement in exercise for overweight/obese women (Edmunds et al., 2007).

A small positive relationship has been noted between physical activity and physical self-concept (e.g., Dishman et al., 2006; Wilson, Rodgers, Loitz, & Scime, 2006). Research has demonstrated that physical self-concept effects both the type (Fox & Wilson, 2008) and amount of physical activity engaged in by various cohorts (Crocker, Sabiston, Kowalski, McDonough, & Kowalski, 2006). Finally, intensity of engagement has been implicated as an important factor to consider given that strenuous physical

activities demonstrate stronger relationships to physical self-concept than moderate intensity activities in adolescent females (Dunton, Schneider, Graham, & Cooper, 2006).

### **Importance of Theory to Informing Health Research**

The utilization of theory in research has been advocated for a scientific and structured examination of the research question (Crosby, Kegler, & DiClemente, 2002; Glanz & Bishop, 2010; Rhodes & Nigg, 2011). An understanding of the importance and benefit of theory in research is vital to understanding the selection of a specific theory to guide the research process (Crosby et al., 2002; Van Ryn & Heany, 1992). While there is no one universally accepted definition of what constitutes a theory, conceptualizations advanced in the literature contain clearly outlined variables formulating the theory and a specific purpose. One parsimonious definition advanced is that a theory is “a set of interrelated concepts, definitions, and propositions that present a systematic view of events or situations by specifying relations among variables, in order to explain and predict the events or situations” (Glanz & Rimer, 1995, p. 11). The nature of a theory allows for the formulation of research hypotheses grounded in previous work. Additionally, theory guides which concepts are selected (or excluded) for examination, as well as informs the measurement of these concepts (Noar & Zimmerman, 2005). As such, certain variables are held stable, allowing for a cumulative knowledge base within the literature. Finally, research conducted under the guidance of a theoretical framework allows for an explanation of the observed phenomena, permitting research to go beyond mere description (Glanz & Bishop, 2010). The theory of particular relevance to the present investigation is Self-Determination Theory (SDT; Deci & Ryan, 1985; 2002), due to its focus on human behaviour, growth, integrated functioning and well-being.

**Self Determination Theory.** SDT (Deci & Ryan, 1985; 2002) is an organismic dialectical theory of human behaviour. SDT is grounded under the guiding principle that people are active organisms with an innate desire for psychological growth and mastery of new challenges (Deci & Ryan, 2002). These innate desires interact with the social context, which can either foster or thwart behaviour and psychological growth. SDT (Deci & Ryan, 1985; 2002) is a broad framework comprised of five mini-theories each of which is briefly described below. Cognitive Evaluation Theory is used to describe the factors (i.e., psychological need fulfillment and the significance of external and intrapersonal events) which facilitate the development of intrinsic motivation. Organismic Integration Theory is focused on all forms of motivation (i.e., amotivation, extrinsic motivation, extrinsic motivation), examining various subtypes that fall along a continuum of internalization. Deci and Ryan (2002) contend that the quality of extrinsic motivation regulating behaviour varies from highly controlled to more self-determined processes. Causality Orientations Theory concerns the examination of individual differences in personality that underpin one's orientation toward autonomous or controlled functioning across life domains. Goal Contents Theory was developed to examine the distinction between intrinsic and extrinsic goals in regards to their unique impact on motivation and well-being. Lastly, Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2002) was advanced to outline the processes through which well-being and optimal growth are facilitated. Given the important role of psychological need fulfillment on well-being across life domains (Vansteenkiste, Niemiec, & Soenens, 2010) including exercise (e.g., Edmunds et al., 2006; Wilson et al., 2006), BPNT (Deci & Ryan, 2002) will be discussed in further detail.

***Basic Psychological Needs Theory.*** Deci and Ryan (2002) claim that three basic psychological needs, competence, autonomy, and relatedness, are innate organismic necessities essential for psychological growth, integrity, and well-being. These psychological needs establish conditions for optimal functioning, such that when fostered authentically these innate needs promote a state of well-being (Deci & Ryan, 2000). Conversely, when needs are actively thwarted, or not authentically fulfilled, a state of ill-being ensues (Ryan & Deci, 2001). As the fulfillment of psychological needs is deemed essential to optimal functioning (Deci & Ryan, 2002), individuals gravitate towards situations that provide the opportunity for their satisfaction (Deci & Ryan, 2002). Psychological needs are differentiated from motives by their conceptualization as innate nutrients rather than acquired motives, and are required by all for healthy functioning (Deci & Ryan, 2000). Deci and Ryan (2000) contend that all three needs are required in combination, such that repercussions (e.g., maladjustment) occur when any one need is not fulfilled.

Both deductive and inductive research founded the proclamation of competence, autonomy, and relatedness as the three basic psychological needs (Deci & Ryan, 2000). Competence refers to feeling effective in one's ability to interact with the environment, and feeling efficacious concerning the completion of challenging tasks (White, 1959). The need for competence is what causes individuals to consistently seek challenges that fall within their capacity, and to strive for mastery of new challenges (Deci & Ryan, 2002). Competence according to Deci and Ryan (2002) is therefore not a specific skill (e.g., riding a bike) but rather a sense of confidence in one's ability to master new challenges (e.g. maintaining an active lifestyle). Autonomy refers to feeling that one is

the origin of their own behaviour (i.e. self-governing), and that their actions are volitional (deCharms, 1968). When individuals act autonomously they feel that their behaviour is an expression of the self (Deci & Ryan, 2002). Individuals can act under the instruction of others and maintain autonomy provided they endorse the instructions themselves (Deci & Ryan, 2002). Relatedness refers to the experience of reciprocal feelings of caring, and a sense of belongingness between individuals (Baumeister & Leary, 1995). Relatedness reflects a desire to connect with others without any concern for attaining a desired outcome, and is what leads individuals to engage in interactions and contexts where this sense of connection can be felt (Deci & Ryan, 2002).

The relationship between satisfaction of psychological needs and well-being is well documented within a variety of cultures and contexts (Chirkov, Ryan, Kim, & Kaplan, 2003; Deci & Ryan, 2002). In other words, the fulfillment of basic psychological needs is necessary regardless of gender, culture, socioeconomic status, and is impervious as to whether an individual values competence, autonomy and relatedness for optimal growth and development to ensue (Deci & Ryan, 2011). Research has demonstrated that daily satisfaction of each basic psychological need explained daily fluctuations in well-being over time (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000), highlighting the importance of need fulfillment for well-being.

***Basic Psychological Needs Theory in the Context of Exercise.*** Support for the original tenets of BPNT (Deci & Ryan, 2002) has been demonstrated within the context of exercise (Wilson & Rodgers, 2007). Cross-sectional research examining the relationship between need satisfaction extended via exercise and markers of well-being notes a consistent pattern of small-to-moderate positive correlations (e.g., Edmunds et al.,

2006; Standage, Gillison, Ntoumanis, & Treasure, 2012; Vlachopoulos & Karavani, 2009; Wilson et al., 2006; Wilson et al., 2009; Wilson et al., 2004). Closer inspection of the available evidence suggests that support for the independent contributions of competence, autonomy, and relatedness as direct predictors of well-being is unequivocal (cf. Wilson, Mack, Gunnell, Oster, & Gregson, 2008). More specifically, psychological need fulfillment in the form of relatedness to others in exercise settings has inconsistently predicted well-being, specifically when examined in association with competence and autonomy (Gunnell, Mack, Wilson, & Adachi, 2011; McDonough & Crocker, 2007; Wilson & Bengoechea, 2010; Wilson et al., 2008).

Further investigation into the tenets of BPNT (Deci & Ryan, 2002) has been documented via examination of the relationship between psychological need satisfaction and markers of well-being across multiple time points (i.e., longitudinal designs). Wilson and colleagues (2006) collected data at two time points spanning a 12-week period, and noted small-to-moderate positive relationships between psychological need satisfaction and well-being at both time points. Fluctuations in the needs for competence and autonomy, but not relatedness, correlated with changes in well-being over time, providing partial support for BPNT (Wilson et al., 2006). Edmunds and colleagues have conducted two studies testing BPNT within the exercise context (Edmunds, Ntoumanis, & Duda, 2007; Edmunds, Ntoumanis, & Duda, 2008). In 2007, employing a 3-wave, longitudinal design spanning a 3-month intervention period, Edmunds and colleagues reported that fulfillment of choice and volition consistent with autonomy predicted satisfaction with life over time in a sample of overweight and obese women. Furthering these findings, Edmunds and colleagues (2008) examined the relationship in a group based exercise class

comprised of female university staff and students assigned to either an SDT based teaching style ('autonomy supportive') or a traditional ('control group') teaching approach over a 10-week period. Results indicated that greater fulfillment of the psychological need for competence predicted lower negative affect at baseline. Most recently, change in psychological need fulfillment of competence and relatedness predicted changes in physical and mental quality of life across a six month exercise referral scheme in a large sample of adults referred to exercise by a General Practitioner (Rahman, Thorgerson-Ntoumani, Thatcher, & Doust, 2011). Finally, naturally occurring changes in physical activity across a six month period were associated with psychological need fulfillment (Mack et al., 2012).

A number of plausible explanations may be advanced concerning the inconsistent role of psychological need satisfaction in predicting well-being in physical activity (and exercise) contexts. These explanations include the nature of the design (cross-sectional vs. longitudinal), differences in the psychological need satisfaction and well-being instruments used, the cohort sampled and the temporal period spanning the investigation.

Within BPNT, Deci and Ryan (2002) did not advance behavioural suggestions. In other words, whether the fulfillment of the psychological needs for competence, autonomy or relatedness would be associated with behavioural outcomes such as physical activity (and exercise) behaviour was not advanced. Despite this, researchers have examined the tenability of this relationship with tentative support. More specifically, support for a positive relationship between physical activity behaviour and the fulfillment of the three psychological needs has been noted (Mack et al., 2012). Additionally, other researchers have found support for the fulfillment of independent needs (i.e., competence;

Edmunds et al., 2006; Standage et al., 2011, and relatedness; Edmunds et al., 2007).

Finally, Rahman et al. (2011) noted that change in autonomy was associated with change in physical activity behaviour in the six month period which followed the exercise intervention.

### **Research Questions**

This research aims to address two specific questions. First, what is the pattern of association between MVPA and indices of well-being over time? Second, what is the role of fulfilling the psychological needs for competence, autonomy and relatedness in the well-being – MVPA relationship?

Consistent with study questions and relevant literature, a number of hypotheses were put forth for testing within the present study. Based on previous research (e.g., Edmunds et al., 2006; Gunnell et al., 2011; Mack et al., 2012; Wilson et al., 2006) and BPNT (Deci & Ryan, 2002) the following hypotheses were addressed:

1. A small-to-moderate positive association between MVPA and well-being was hypothesized.
2. It was hypothesized that psychological need satisfaction would be positively correlated with MVPA and well-being.
3. It was hypothesized that psychological need satisfaction would mediate the MVPA – well-being relationship.
4. It was hypothesized that psychological need satisfaction over time would mediate the MVPA (Time 1) – well-being (Time 3) relationship.



### **Significance of Proposed Research**

The proposed research has the potential to extend the literature examining the MVPA – well-being relationship in at least three ways. First, through multiple mediation analysis, the present investigation has the potential to contribute knowledge concerning the process of change through which MVPA contributes to well-being overtime. Ryan and Deci (2001) argue that BPNT is a useful framework for understanding eudaimonic well-being, specifically advocating that it is the fulfillment of the basic needs of competence, autonomy, and relatedness that promotes this form of well-being. Further, research supporting the contention that psychological needs serve as mediators between physical activity (and exercise) and well-being has emerged (Gunnell et al., 2011; Mack et al., 2012). Examination of the potential role of basic need fulfillment in the exercise behaviour – well-being relationship is warranted in order to clarify the mechanisms through which well-being is enhanced. Given the longitudinal design of the present investigation, knowledge gained may complement existing cross-sectional research (e.g., Gunnell et al., 2011) and afford practitioners greater insight into the processes through which MVPA is associated with well-being.

Similarly, the use of serial mediation as a statistical procedure (Hayes, 2013) is novel both within exercise psychology and the broader psychological literature. The present investigation has the potential to further knowledge concerning the utility of this statistical approach for examining mediation within the exercise context over time. Given that serial mediation analyses permit the examination of the process through which one mediator influences another leading to the final outcome allows for a more in-depth

understanding of the role of psychological need satisfaction as a mechanism through which MVPA influences well-being

Finally, the present investigation has the potential to further knowledge concerning the role of intensity in the well-being – MVPA relationship. Much of the existing literature examining the influence of exercise intensity on an individual's well-being has been conducted based on a single bout of activity (Craft & Landers, 1998). Fewer studies have specifically examined the association between the intensity “typically” engaged in by an individual over time and well-being. However there is research to suggest that intensity of exercise serves as a unique predictor of well-being (e.g., Cerin et al., 2009; Dunton et al., 2006; Molina-García et al., 2011). Additionally, a relationship between exercise intensity and the psychological need of competence has been identified (Edmunds et al., 2006). In the present study, participation is restricted to individuals who engage in MVPA, which will allow for a better understanding of the well-being benefits associated with physical activity engaged in at an intensity commensurate with health benefits.

## **Methods**

### **Participants**

Non-probability based sampling was employed, with participants ( $N = 211$ ) required to be: (a) 18 years of age or older, (b) have no ambulatory restrictions limiting engagement in moderate-to-vigorous intensity exercise, (c) have the ability to read English, (d) currently exercising in a commercial fitness facility, and (e) willing to commit to the length of the study. The target sample size was determined based on a fixed alpha level ( $\alpha = 0.05$ ), a medium effect size ( $d = 0.50$ ), and a conservative power

estimate ( $\beta = 0.80$ ; Cohen, 1992). Oversampling was conducted in order to compensate for participant dropout between time points as well as any necessary case deletion due to missing data. With attrition over time difficult to predict, researchers (e.g., Martin Ginis et al., 2008) have adopted a rate of 5 – 10% in their investigations. In an effort to be conservative, a total attrition rate of 20% (i.e.,  $n = 17$ ) was anticipated across the three time points spanning this investigation. As such, the target sample size was a minimum of 101 participants.

### **Instruments**

**Demographics.** Participants responded to a number of self-report questions such as age, gender, ethnicity, height, weight, in order to provide a description of the sample.

**Eudaimonic Well-Being.** The Subjective Vitality Scale (SVS; Ryan & Frederick, 1997) is a 7-item instrument designed to measure eudaimonic well-being through the assessment of participant's perceptions of feeling alive and vital. To assess eudaimonic well-being as experienced in exercise contexts, the following stem was provided to contextualize the SVS items "Please respond to each of the following statements by indicating the degree to which the statement is true when you engage in moderate and vigorous exercise". Participants responded to each item (sample item: "I feel energized") across a 7-point Likert-scale anchored at the extremes from 1 (*not at all true*) to 7 (*very true*). Participant responses were summed and averaged across the number of items to form an overall score, with higher scores representing greater eudaimonic well-being.

Structural validity has been demonstrated for scores from the global 7-item SVS scale (Bostic, Rubio, & Hood, 2000) and for select aspects of construct validity in exercise contexts (Wilson et al., 2006). When modified to exercise contexts, support for

construct validity of SVS scores has been demonstrated via correlations with markers of well and ill-being and behavioural regulation (Edmunds et al., 2007; Edmunds et al., 2010). Estimates of internal consistency (i.e., Cronbach  $\alpha$ 's; Cronbach, 1951) for SVS scores contextualized to exercise (Edmunds et al., 2010) and physical activity settings (Gunnell et al., 2011) have ranged from 0.89 – 0.94.

**Hedonic Well-Being.** The short form Positive and Negative Affect Scale (PANAS; Mackinnon, Jorm, Christensen, Korten, Jacomb, & Rodgers, 1999) is a 10-item questionnaire assessing positive and negative affect. To reflect affective experiences in exercise contexts participants were asked to respond to each item following the stem “please indicate to what extent you generally feel this way when you engage in moderate-to-vigorous exercise”. Utilizing a 5-point Likert-scale anchored at the extremes from 1 (*very slightly or not at all*) to 5 (*very much*) participants were asked to rate the extent to which they have experienced each affective state in the past 7 days. Participants were asked to respond to 5 items assessing positive affect (sample item: “excited”) and 5 items assessing negative affect (sample item: “upset”), with higher scores for positive items indicative of feeling enthusiastic and alert and higher scores for negative items being indicative of feelings of distress. The 5 items from each subscale were averaged to form an overall affect score.

Support for structural validity of the short form PANAS has been demonstrated through factor analysis (Mackinnon et al., 1999). Scores from the PANAS have demonstrated support for construct validity (Mack et al., 2012; Wilson et al., 2006) in various physical activity contexts. Cronbach (1951) estimates of internal consistency

have been demonstrated to range from 0.85 to 0.93 (Mack et al., 2012; Wilson et al., 2006).

**Physical Self Concept.** The physical self-concept subscale of the Physical Self-Description Questionnaire (PSDQ-PSC; Marsh, Richards, Johnson, Roche, & Tremayne, 1994) is a 6-item global evaluation of the level of positive feelings a person has about themselves. Participants were asked to respond to each item on a 6-point Likert scale ranging from 1 (*false*) to 6 (*true*), with a higher score indicating greater physical self-concept. Sample items include “I am satisfied with the kind of person I am physically” and “I feel good about the way I look and what I can do physically”.

Internal consistency reliability estimates (Cronbach, 1951) demonstrate internal consistency for this subscale ( $\alpha = 0.90$ ; Marsh et al., 1996). Support for the validity of the 6-item PSDQ subscale has been demonstrated, with evidence of structural validity provided through factor analytic and multitrait-multi-method procedures (Marsh, 1996; Marsh et al., 1994). Construct validity has been demonstrated through research supporting theoretically consistent links with physical fitness (Marsh, 1997) and psychological need satisfaction (Wilson & Bengoechea, 2010).

**Leisure-Time Physical Activity.** The Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shepard, 1985) is a 3-item instrument designed to assess the frequency of mild, moderate, and vigorous physical activity that last a minimum of 15 minutes in duration, across the span of a week. Given the focus on moderate and strenuous activity in the present investigation, only items reflecting these two dimensions were retained. Participants were asked to indicate the number of times they engaged in moderate and vigorous exercise during a typical week. Responses to

these two items were used to create an overall metabolic equivalent score (METs) using a mathematical formula  $[(\text{Moderate} \times 5) + (\text{Strenuous} \times 9)]$ . Individuals with a GLTEQ score of 14 units or greater were included in the analysis (Godin, 2011). Cut scores for the GLTEQ were developed to align with recommendations from the Surgeon General (U.S. Department of Health and Human Services, 1996, 1999), as well as the health benefits associated with certain volumes of exercise (Godin, 2011). The single item indicator assessing frequency of physical activity engaged in “enough to work up a sweat” (Godin & Shepard, 1985) was also utilized as a separate estimate of exercise intensity. Participants were asked to respond to the question “During a typical 7-Day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)? Participants responded by selecting one of the three response options provided (1 = often, 2 = sometimes 3 = never/rarely).<sup>1</sup> In order to assess exercise rather than physical activity, the items were modified to reflect the exercise context. This involved altering the items by replacing the words ‘physical activity’ with the word ‘exercise’.

Correlations between MET scores and indices of physical fitness demonstrates concurrent validity for the original 3-item GLTEQ (Jacobs, Ainsworth, Hartman, & Leon, 1993) with support for test scores in young adult samples noted (Wilson et al., 2006). The test–retest reliability of overall GLTEQ scores across 2 weeks has been reported as 0.74 in a sample of healthy adults (Godin & Shepard, 1985). Construct validity support for the inclusion of moderate and vigorous intensity activities has been provide through negative correlations with indices of body composition (e.g., body fat percentage; Godin & Shepard, 1985) and positive correlations with cardiorespiratory

fitness (i.e.,  $\text{VO}_2\text{max}$ ) and with engagement in strenuous activities particularly salient (Godin, 2011).

**Perceived Exertion.** The Borg Perceived Exertion Scale (RPE; Borg, 1982) was used to measure exercise intensity. Designed to directly parallel heart rate (Borg, 1998), the RPE measures the intensity of perceived exertion on a 15-point scale representing equal intervals and ranging from 6 (“no exertion at all”) to 20 (“maximal exertion”). Seven of the 13 numerical ratings are anchored with labels (e.g., very light, heavy). Participants were asked to respond in terms of how they usually feel while exercising at a moderate to vigorous intensity (“Please respond to the following statement by indicating generally, what is your perception of exertion when you engage in moderate to vigorous exercise. This feeling should reflect how heavy and strenuous the generally exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion”). Support for the use of the RPE as an estimate of perceptual intensity of effort has been noted (Noble & Noble, 1998).

**Psychological Need Satisfaction.** The Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) is an 18-item scale grounded in SDT and BPNT (Deci & Ryan, 2002) that assesses perceived psychological need satisfaction specific to exercise. The psychological needs of competence, autonomy, and relatedness are assessed via 6-items each, and sample items include ‘I feel that I am able to complete exercises that are personally challenging’ (Competence), ‘I feel free to exercise in my own way’ (Autonomy), and ‘I feel attached to my exercise companions because they accept me for who I am’ (Relatedness). Participants were

asked to respond to each item in terms of how they felt engaging in moderate to vigorous exercise over the past 7 days (“The following statements represent different feelings people have when they engage in exercise. Please answer the following questions by considering how you have typically felt when you engaged in moderate to vigorous exercise over the past 7 days”). Participants responded to each item via a 6-point Likert scale from 1 (*false*) to 6 (*true*). Higher scores are representative of greater need satisfaction.

Psychometric properties of the PNSE have been examined, demonstrating the usefulness of this instrument for examining psychological need satisfaction within an exercise context. Wilson and colleagues (2008) conducted a systematic review concerning reliability and validity of scores derived from the PNSE. Internal consistency reliability estimates (Cronbach, 1951) ranging from 0.84 to 0.96 and high score stability (i.e., test-retest reliability) were documented and provide support for use of the scale (Wilson et al., 2008). Support has been found for structural and generalizability validity of the scale, as well as for invariance across gender and exercise setting (Wilson et al., 2008; Wilson et al., 2006).

## **Procedures**

This study employed a three-wave, non-experimental, longitudinal design. Following ethical clearance (see Appendix A), exercisers were recruited through undergraduate and graduate courses at Brock University. Course instructors were contacted in order to gain permission to enter the classes to explain the study to potential participants (see Appendix B). The nature of the study was announced in class (see Appendix C), and willing participants were scheduled to complete the surveys in small



groups at a mutually convenient time. After being introduced to the study, each participant was provided with an informed consent form (see Appendix G), a letter of invitation (see Appendix E), and a questionnaire package (see Appendix F). After the completion of the questionnaires at Time 1 (T1) participants were scheduled to return at a mutually convenient time three weeks later to complete the same survey instruments with the exception of items assessing demographic information. Upon completion of the questionnaires at time two (T2), the participants were scheduled to return and complete the questionnaires once more three weeks later (i.e., T3). Approximately one week prior to the T2 and T3 test administration period, participants were sent an e-mail reminder of the next data collection period (see Appendix D). Participants were provided with a debriefing form (see Appendix H) where they could provide contact information if they wished to receive a summary of the major findings of the study. Participants did not receive any form of monetary compensation for participation.

### **Data Analysis**

Data analysis proceeded in sequential stages. First, preliminary data analysis was conducted in order to examine patterns of missing data, and whether statistical assumptions were met for the intended analyses. Cases were removed from subsequent analysis if no information was provided by the participant, or if the participant did not engage in moderate and/or vigorous exercise as assessed through the GLTEQ. Appropriate parametric (e.g., independent samples t-tests) and non-parametric (e.g., chi-squared analysis) analyses were calculated for demographic, MVPA, well-being, physical self-concept, and psychological need satisfaction variables to determine if differences existed between those who completed all three time points and those who dropped out of

the study. Effect sizes (Cohen's  $d$ ; Cohen, 1988 and phi coefficients; Grissom & Kim, 2005) were calculated and interpreted to determine the magnitude of practical significance. For participants providing information at all three time points, well-being, physical self-concept, and psychological need satisfaction variables were screened for missing values. Within-person mean substitution was conducted for any cases with less than 50% of the data missing (Hawthorne & Elliot, 2005).

Second, descriptive statistics and the examination of univariate normality was undertaken for scores from all study variables. Estimates of internal consistency (Cronbach's  $\alpha$ ; Cronbach, 1951) were computed to determine the reliability of scores from instruments assessing well-being, physical self-concept, and psychological need satisfaction.

Third, bivariate correlations (Pearsons  $r$ ) were calculated between GLTEQ scores and all psychological variables at each of the three time points. Standardized residuals were calculated to determine change across study variables. Standardized residuals were calculated for each possible pairwise combination (i.e., T1 – T2, T1 – T3 and T2 – T3) consistent with Rahman and colleagues (2011). For example, the standardized residual or change score of each variable was determined using regression analysis, with T1 being the independent variable and T2 the dependent variable. Bivariate correlations were calculated to examine patterns of association between variables based on change scores. Confidence intervals were calculated to provide an additional source of information related to null hypothesis significance testing (Thompson, 2001).

To test the secondary research question, multiple mediation analysis was conducted using bootstrapping procedures advocated by Preacher and Hayes (2007).

Bootstrapping is a non-parametric resampling procedure that creates a new sample size based on replacement of cases from the original dataset (Preacher & Hayes, 2008). The recommended bootstrap sample of 5000 ( $k = 5000$ ; Preacher & Hayes, 2008) was used for the current study. Bootstrapping produces a 95% bias corrected and accelerated confidence interval (BCaCI; Efron, 1987; Efron & Tibshirani, 1993) that is asymmetrical which in turn reduces the Type I error rates. Mediation (or an indirect effect) occurs if the BCa CI does not contain zero (Preacher & Hayes, 2008). Specific indirect effects were also examined through the use of BCa CIs to examine the unique contribution of each potential mediator in the model (i.e. competence, autonomy, relatedness). For the purpose of this analysis MVPA and PNSE were taken at the same point in time while well-being was taken at a later timepoint. Multiple mediation analyses were conducted to examine whether variation in each of the psychological needs influenced change in the exercise behaviour – well-being relationship.

Serial mediation analyses with bootstrap methods advocated by Hayes (2013) were conducted. Serial multiple mediator models allow for the examination of direct and indirect effects of one variable on another while modelling the process through which one mediator influences another leading to the final outcome. For the purpose of this analysis MVPA was taken at Time 1, while well-being at the final test administration was considered the outcome. Psychological need satisfaction was taken at each of the three test administrations and considered as three possible mediating variables. Within the serial mediation analysis it is assumed that a casual relationship is present between the mediating variables. Serial mediation analyses were conducted to examine whether

variation in psychological need satisfaction at each of the three time points influenced the MVPA – well-being relationship.

## **Results**

### **Preliminary Data Analysis**

A total of 211 individuals provided consent to participate in this study. Thirty-seven individuals failed to meet inclusion criteria and were excluded from all analyses. More specifically, thirty-six individuals did not exercise at a commercial fitness facility and one individual did not report engaging in MVPA. An additional 27 individuals were excluded from analysis due to failure to provide information at all three test administrations ( $n = 15$  provided data at the first data collection period only;  $n = 12$  provided data at the first two collection periods only).

Parametric (e.g.,  $t$ -tests) and non-parametric tests (e.g.,  $\chi^2$ ) significance tests were conducted on demographic and study variables taken at baseline to determine whether differences existed between those who completed the three test administrations and those who did not (see Table 1). Statistically significant differences in participant responses were not noted, with the exception of subjective vitality ( $p = .03$ ; see Table 1). All subsequent analyses were performed on a final sample of 147 individuals.

Missing Values Analysis was conducted for all study variables in order to examine patterns of missing data. Results of the analysis revealed that all data was missing at random, and that quantity of missing data was not a cause for undue concern as missing data ranged from 0 – 2% in this sample (Tabachnick & Fidell, 2007). Missing data values were imputed using an expectation maximization technique in SPSS Version 20.

### **Sample Characteristics**

The final sample ( $N = 147$ ) was comprised of 80 females ( $M_{\text{age}} = 22.56$ ;  $SD_{\text{age}} = 1.43$ ) and 67 males ( $M_{\text{age}} = 20.84$ ;  $SD_{\text{age}} = 1.39$ ). Average Body Mass Index (BMI) values for this sample fell within the “healthy” range ( $M_{\text{BMI}} = 23.96$ ;  $SD_{\text{BMI}} = 3.38$ ; Health Canada, 2013). All participants (100.00%) identified with being single/never married, and the majority of participants identified their ethnicity as Caucasian (92.50%).

### **Descriptive Statistics and Estimates of Internal Consistency**

Descriptive statistics, estimates of normality and internal consistency of test scores across all three test administration periods were calculated (see Tables 2-5). On average, participants reported engaging in MVPA ranging from a high of 66.14 ( $SD = 39.54$ ) METS per week at Time 1 to 58.72 ( $SD = 30.63$ ) METS at Time 3. When considering markers of well-being (i.e. PA, SVS, and PSDQ-PSC) participants reported average levels that fell above the mid-point of response scale options. The present sample reported low levels of negative affect, with the average score falling below the theoretical mid-point for the response scale for all test administration periods. At all three test administration periods, participants indicated that they perceived their psychological needs fulfilled within the exercise context, as scores for competence, autonomy and relatedness fell above the theoretical mid-point of the response scale options.

The assumption of normality was tested by examining skewness and kurtosis values for each study variable (see Tables 2-5; Glass & Hopkins, 1996) across all test administrations. Examination of skewness values revealed no major cause for concern (values ranged from -1.80 to 1.96; Glass & Hopkins, 1996). Kurtosis values were within

an acceptable range for well-being variables (-0.48 to 2.81) with the exception of negative affect at Time 2 which was leptokurtic. In regards to psychological need satisfaction, autonomy at both Time 1 and Time 2 were moderately leptokurtic (4.97 and 3.69 respectively).

Estimates of internal consistency (Cronbach's  $\alpha$ ; Cronbach, 1951) were calculated for test scores derived from indices of well-being and perceived psychological need fulfillment. Results of the analysis revealed that Cronbach's  $\alpha$ 's ranged from 0.58 to 0.97 at Time 1 (see Table 2), 0.75 to 0.98 at Time 2 (see Table 3), and 0.71 to 0.98 at Time 3 (see Table 4).

**Patterns of association between study variables (Cross sectional).** Pearson bivariate correlations were calculated between MVPA, indices of psychological need satisfaction and well-being (see Tables 5-7). Consistent through all three test administrations, small-to-moderate associations were evident between indices of well-being in the hypothesized direction ( $r_{12}$ 's ranged from .29 to .66). Negative affect tended to display a weak negative relationship with other indices of well-being. A pattern of small-to-moderate correlations was evident between the three psychological needs postulated by Deci and Ryan (2002) at each of the test administrations ( $r_{12}$ 's ranged from .26 to .58). However it should be noted that satisfaction of the psychological need for relatedness and satisfaction of the psychological need for autonomy were only significantly positively associated at the third test administration ( $r_{12} = .25 p < .01$ ).

MVPA consistently demonstrated a significant small-to-moderate association with indices of well-being in the hypothesized direction ( $r_{12}$ 's ranged from .16 to .29). When negative affect served as the well-being marker, no significant association with

MVPA was noted. In regards to psychological need satisfaction, significant small-to-moderate correlations were consistently noted between MVPA and satisfaction of competence and relatedness in exercise settings ( $r_{12}$ 's ranged from .16 to .25). A pattern of small-to-moderate correlations were evident between psychological need satisfaction and well-being indices at each of the test administrations ( $r_{12}$ 's ranged from .16 to .68). Negative affect displayed a significant negative relationship with satisfaction of the need for competence at time 2 ( $r_{12} = -.20$ ) and with satisfaction of the need for autonomy at time 3 ( $r_{12} = -.27$ ).

**Patterns of association between study variables (Change scores).** Pearson bivariate correlations were calculated between standardized residual scores calculated for MVPA, indices of need satisfaction and well-being (see Tables 11-13). Consistent through all three test administrations, small-to-moderate associations were evident between change in indices of well-being in the hypothesized direction ( $r_{12}$ 's ranged from .15 to .53). Significant small-to-moderate associations were consistently noted between change scores for indices of MVPA and well-being in the hypothesized direction ( $r_{12}$ 's ranged from .15 to .19). As such, changes (i.e., increases) in MVPA were associated with corresponding increases in well-being over time. Change in MVPA was significantly associated with change in positive affect ( $r_{12}$ 's ranged from .17 to .18) in the expected direction across all contrasts examined. Change in MVPA was significantly associated with change in physical self-concept ( $r_{12}$ 's ranged from .15 to .19) with the exception of Time 2 – Time 3 ( $r_{12} = .02$ ). Change in MVPA was only significantly associated with change in subjective vitality Time 1 – Time 2 ( $r_{12} = .16$ ). Inconsistent with study hypotheses, change in MVPA was shown to have a significant positive association with

change in negative affect ( $r_{12}$ 's ranged from .16 to .21 see Tables 10 and 11) across two of the three administration periods.

Change in MVPA was not statistically significantly associated with change in psychological need satisfaction, with the notable exception of the negative relationship with perceived satisfaction of the need for autonomy ( $r_{12} = -.15$ ) at Time 2 – Time 3. A pattern of small-to-moderate correlations were evident between change in well-being indices and change in psychological need satisfaction in the hypothesized direction ( $r_{12}$ 's ranged from .09 to .43 see Tables 9-11). A small-to-moderate positive association was noted between changes in the three psychological needs ( $r_{12}$ 's ranged from .12 to .51 see Tables 9-11) in the hypothesized direction.

### **Main Analyses**

**Multiple Mediation.** Results of the bootstrapping procedure to test for multiple mediation across time points can be found in Tables 11-13. In all analyses MVPA and psychological need satisfaction were taken from one test administration (e.g., Time 1) with markers of well-being taken at a more distal administration periods (i.e., Time 2 or Time 3). Comparable results were noted regardless of the time frame which encapsulated the analysis. When physical self-concept or subjective vitality served as the criterion variable, variation in psychological need satisfaction mediated the MVPA – well-being relationship. Interpretation of the specific indirect effects indicated that competence served as a unique mediator when considering subjective vitality or physical self-concept as the indicator of well-being. A different pattern of results emerged when affective indices served as the markers of well-being. Regardless of test administration period,



neither the MVPA-negative affect relationship nor the MVPA – positive affect relationship was mediated by variation in psychological need satisfaction.

**Serial Mediation.** The degree to which perceived psychological need satisfaction at each test administration mediated the relationship between MVPA at Time 1 and indices of well-being at Time 3 (see Figure 1) was tested using a serial mediation analysis with bootstrap methods (Hayes, 2012).

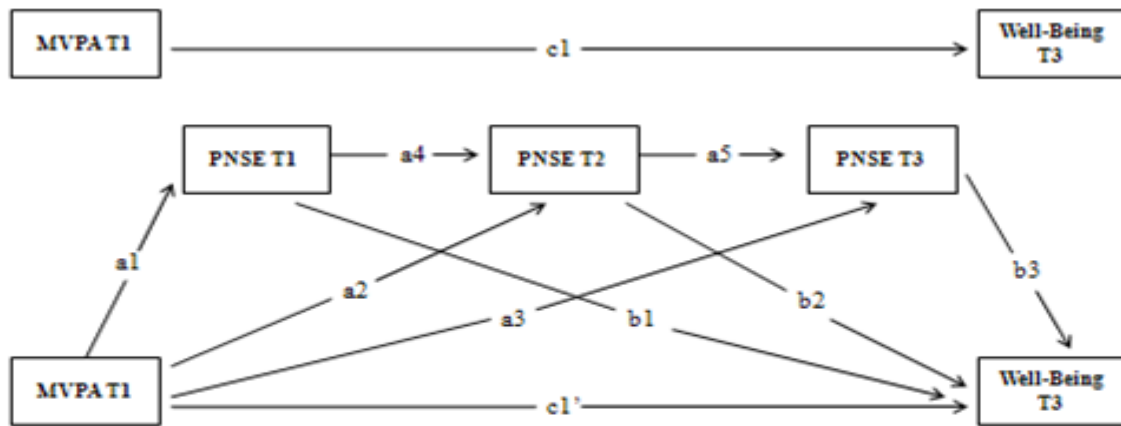


FIGURE 1. A serial multiple mediation model with PNSE T1, PNSE T2, and PNSE T3 as proposed mediators of the MVPA T1 and Well-Being T3 relationship. MVPA = Moderate to Vigorous Physical Activity; PNSE = Psychological Need Satisfaction in Exercise.

There was a significant total effect ( $c1$ ) of MVPA on well-being when PSDQ-PSC ( $\beta = .0050$ ,  $t = 2.60$ ,  $p = .01$ ) and SVS ( $\beta = .0051$ ,  $t = 2.25$ ,  $p = .03$ ) served as the outcome variable of interest. Significant direct effects ( $c1'$ ) were noted between MVPA and PSDQ-PSC ( $\beta = .0036$ ,  $t = 2.26$ ,  $p = .03$ ). Total indirect effects were not significant regardless of the well-being indicator being examined (confidence intervals spanning zero). Examination of the specific indirect effects indicated that mediation was evident when considering PSDQ-PSC and SVS as indicators of well-being. The indirect effect through MVPA T1 through PNSE T1, to PNSE T2, to PNSE T3 was significant for PSDQ-PSC ( $a1a4a5b3 = .0007$ ;  $CI = .0001$  to  $.0023$ ) and SVS ( $a1a4a5b3 = .0010$ ;  $CI =$

.0001 to .00130). Therefore, increased MVPA was associated with increased psychological need satisfaction at Time 1, which in turn was positively associated with psychological need satisfaction at Time 2. Psychological need satisfaction at Time 2 was further associated positively with psychological need satisfaction at Time 3 which resulted in greater PSDQ-PSC or SVS. Also of note, mediation was not evident when positive or negative affect served as the outcome variable of interest. Path coefficients for the serial mediation analyses can be found in Table 14.

### **Discussion**

Physical activity (and exercise) has been advocated as a means through which well-being can be enhanced or achieved (Biddle & Ekkekakis, 2005; Bouchard et al., 2007; Fox & Wilson, 2008). However, the nature of the exercise – well-being relationship is complex (Biddle & Ekkekakis, 2005) with conclusions attesting to the benefits of exercise linked to variation in markers of well-being (Netz et al., 2005), mode of exercise (Solberg, Hopkins, Ommundsen, & Halvari, 2012), duration and intensity of exercise (Reed & Ones, 2006; Sylvester et al., 2012) and study quality (Reed & Buck, 2009). The main purpose of the present investigation was to determine the association between MVPA and indices of well-being over time. Grounded in BPNT (Deci & Ryan, 2002), the secondary objective was to determine the role of fulfilling psychological needs for competence, autonomy, and relatedness in the MVPA – well-being relationship.

The data from the present investigation provided a number of findings worthy of mention. First, increased MVPA was generally associated with increased well-being based on results conducted both at the level of cross-sectional analysis and change scores over time. Second, psychological need satisfaction generally demonstrated a significant

positive relationship with both MVPA and indices of well-being, albeit autonomy displayed an inconsistent pattern of relationships. Finally, in response to the secondary research objective, mediational analysis revealed that psychological need satisfaction mediated the relationship between MVPA and indices of well-being, with changes in competence emerging as the primary mechanism influencing well-being.

### **Comparison of Study Participants to Previous Research**

Descriptive statistics derived from study variables at each test administration period relay characteristics of the study participants relative to existing literature. Using scores from the GLTEQ (Godin & Shepard, 1985), the present sample displayed levels of MVPA consistent with previous research using samples comprised primarily of undergraduate students (e.g., Sylvester et al., 2012; Wilson & Muon, 2008) but higher than that reported in older cohorts (e.g., Edmunds et al., 2006). This corresponds to literature documenting a decline in LTPA in older populations (Gilmour, 2007). When considering indices of well-being, this sample demonstrated high levels of positive affect and low levels of negative affect, which is consistent with previous literature using young adults (e.g., Mack et al., 2012). Participants also indicated high levels of subjective vitality, which is consistent with the data reported by Wilson and colleagues (2006), and levels of physical self-concept consistent with previous studies of university cohorts (Wilson et al., 2006). Finally, consistent with existing literature (e.g., Edmunds et al., 2006; Wilson et al., 2006), the present sample reported that their basic psychological needs were highly satisfied within exercise contexts with perceptions of competence most endorsed and relatedness in exercise least satisfied.

## **MVPA and Well-Being**

The primary purpose of the present investigation was to examine the relationship between MVPA and well-being across three test administrations each separated by three weeks. Consistent with study hypotheses and previous research (e.g., Edmunds et al., 2006) a statistically significant correlation was evident between MVPA and all indices of well-being at each test administration. The relationship between greater physical activity and greater subjective vitality and positive affect has previously been noted in samples of university students (e.g., Wilson et al., 2006) and exercisers (Edmunds et al., 2006). Similarly, the relationship between greater MVPA and greater physical self-concept is consistent with research by Marsh and colleagues (2006). Finally, that increased MVPA was associated with reductions in negative affect at each test administration is consistent with Edmunds and colleagues (2007).

Examination of the relationship between MVPA and indices of well-being based on change scores revealed many of the patterns noted from observational data. More specifically as MVPA increased over time, so too did individuals' well-being. However, two exceptions are worthy of attention. Specifically, change in subjective vitality was only significantly ( $p < .05$ ) associated with change in MVPA between the first and second test administration period. In an effort to explain this inconsistency, consideration of study design, statistical artifacts, and sample characteristics is warranted. First, current conclusions underscoring the nature of the physical activity - vitality relationship have largely been based on observational studies in young adults (e.g., Molina-Garcia et al., 2011; Wilson et al., 2006) or population health data (Wendel-Vos et al., 2004). While results of these studies cannot be ignored, the quality of the conclusions may be limited

(Crocker & Algina, 1986). Further, findings demonstrating the positive association between physical activity and vitality generated from population health data affords statistical but little clinical (i.e., meaningful) significance given the large sample sizes typical of these investigations (Tessier et al., 2007). Second, response frequencies for each subjective vitality item demonstrated that at least 15% of participants scored 6 or greater at each test administration while only 7.5% or fewer scored 4 or fewer. As such, that increases in MVPA were not consistently associated with increased perceptions of subjective vitality may be linked to a statistical artifact known as a ceiling effect which can be problematic in longitudinal data analysis (Wang, Zhang, McArdle, & Salthouse, 2009). Finally, what is known about the relationship between changes in physical activity and vitality over time is mainly limited to older adults (e.g., Solberg et al., 2012) or cohorts living with a chronic health condition (i.e., Häkkinen, Rinne, Vasankari, Santtila, Häkkinen, & Kyröläinen, 2010; Tessier et al., 2007). As such, characteristics of the sample such as age or health status may account for the differences in findings attesting to the physical activity – vitality relationship in the present investigation with those of existing literature.

A second inconsistency was the statistically significant positive relationship between change in MVPA and change in negative affect noted for two of the three test administration periods. A positive relationship between physical activity and negative affect has been noted in previous research (e.g., Gunnell et al., 2011). While it is largely believed that exercise makes you feel better, emerging literature demonstrates that the effect of exercise on affect is largely dependent on exercise intensity (Biddle & Ekkekakis, 2005). Specifically, more intense exercise is associated with greater negative

affect during a single bout of exercise (Bixby, Spalding, & Hatfield 2001; Ekkekakis, Hall, & Petruzzello, 2004; Hall, Ekkekakis, & Petruzzello, 2000). Given the focus of the present investigation on MVPA it is feasible that this cohort experienced a greater sense of negative affect as a result of the intensity of activity than experienced by those engaging in less strenuous exercise.

### **Association of Psychological Need Satisfaction with Behaviour and Well-Being**

Study hypotheses stating that MVPA would be positively related with scores from the PNSE were partially supported. Perceptions of competence and relatedness emerged as being positively associated with MVPA while perceived autonomy was negatively associated with MVPA when examined at a single point in time. This pattern of relationships is consistent with existing research (Mack et al., 2012; Wilson & Muon, 2008) demonstrating that competence and relatedness, but not autonomy, were significantly correlated with physical activity in a sample of university students. When examining the relationship based on change scores there was no relationship between any of the psychological needs and MVPA, with the exception of perceived autonomy which was negatively associated with MVPA at Time 2 – Time 3. Consistent with existing research in young adults (Mack et al., 2010) and older cohorts (Gunnell et al., 2011; McDonough & Crocker, 2007), MVPA appears at best to be negligibly associated with perceptions of volition and the experience a sense of choice and psychological freedom consistent with autonomy in this cohort. Therefore, there is mounting evidence to suggest that perceived autonomy is not as important to physical activity (including MVPA and exercise) behaviour in young adults when compared to perceptions of psychological need satisfaction linked to mastery experiences and social connection to

others. While Deci and Ryan (2000) contend that psychological needs are universal and that all needs must be fulfilled in order for a state of well-being to ensue, they do not make theoretical links between perceptions of psychological need satisfaction with behaviour. With research examining the possible relationship between psychological need satisfaction and behaviour (e.g., Edmunds et al., 2006; Mack et al., 2012) in its infancy, further investigation is warranted to elucidate the extent to which psychological needs are associated with outcomes other than well-being.

Consistent with previous research and study hypotheses a small-to-moderate positive relationship was present between psychological need satisfaction and indices of well-being (i.e., positive affect, subjective vitality and physical self-concept). The relationship between positive affect and PNSE scores is consistent with previous research using cohorts comprised of exercisers (Wilson et al., 2006), university students (Mack et al., 2012) and older adults engaged in dragon boat racing (McDonough & Crocker, 2007). Research by Wilson et al. (2006) demonstrated support for the relationship between subjective vitality and psychological need satisfaction in the expected direction in a sample of university-aged exercisers, although relatedness did not reach statistical significance. It has been noted that perceived relatedness to others in exercise settings inconsistently predicts well-being, and while the pattern of association was in the expected direction the magnitude of the relationship was much smaller than what is typically seen with the other needs (Gunnell et al., 2011; McDonough & Crocker, 2007; Wilson & Bengoechea, 2010; Wilson et al., 2008). Additionally, findings for physical self-concept are consistent with Standage and colleagues (2012) linking psychological need satisfaction and the self-concept dimensions of physical abilities and physical

appearance in secondary school students. Finally, a negative relationship was evident between PNSE scores and negative affect; however the magnitude of the relationship generally failed to attain conventional levels of significance ( $p < .05$ ). This is consistent with previous research which demonstrates a negative relationship between PNSE scores and negative affect in cohorts such as exercisers (e.g., Wilson et al., 2006) and university students (Mack et al., 2012).

Conclusions based on change score analyses between psychological need satisfaction and well-being demonstrated a similar pattern to those observed at a single point in time with exceptions only noted between the first and second test administration. First, change in perceived competence emerged as the psychological need most significantly ( $p < .05$ ) associated with well-being outcomes, with the only other significant relationship between change in perceived relatedness and change in positive affect. Given that perceived competence tends to emerge as the most prominent psychological need in exercise contexts in relation to well-being (e.g., Wilson et al., 2006) and physical self-concept (Standage et al., 2012), this finding is not surprising. Second, changes in PNSE scores were generally not associated with negative affect which may reinforce the belief that psychological need satisfaction is associated more with the promotion of well-being than with its absence (e.g., Mack et al., 2012).

### **Does Psychological Need Fulfillment Mediate the MVPA – Well-Being Relationship?**

It has been established that physical activity is associated with improvement in well-being (Biddle & Ekkekakis, 2005); with emerging evidence suggesting that the intensity of exercise is of particular importance (Molina-García et al., 2011; Sylvester et



al., 2012). However, inquiry into the process through which this occurs is relatively novel (Biddle & Ekkekakis, 2005; Fox, 2002) or limited to select psychological constructs (e.g., social support; McAuley, Blissmer, Marquez, Jerome, Kramer, & Katula, 2000). Consistent with study hypotheses and previous research (e.g., Gunnell et al., 2011; Mack et al., 2012), psychological need satisfaction mediated the relationship between MVPA and physical self-concept at each of the three time points, and between MVPA and subjective vitality at two of the three time points assessed in the present investigation. When considering specific indirect effects it was evident that competence contributed uniquely to these well-being markers. Competence emerged as the strongest unique predictor of well-being at each test administration, while relatedness emerged as an inconsistent mediator. Perceived autonomy did not mediate the relationship. Findings from the present investigation are largely consistent with conclusions noted in individuals living with osteoporosis (Gunnell et al., 2011) and young adults (Mack et al., 2012; Sylvester et al., 2012). Taken collectively, existing research seems to highlight the importance of the fulfillment of the need for competence in physical activity settings. Satisfaction of the needs for autonomy and relatedness appear to be less influential as a mechanism through which well-being can be achieved in physical activity (including exercise) settings. As the importance of perceived relatedness tends to emerge more in research conducted over a longer period of time (e.g., Mack et al., 2012) it is plausible that it is more important in the long term as opposed to the short time-frame captured in this present investigation.

Results of Preacher and Hayes' (2008) bootstrapping procedure revealed that psychological need satisfaction did not mediate the relationship between MVPA and

negative affect at any of the three test administrations. Previous research investigating the role of psychological need satisfaction in the physical activity – negative affect relationship has been equivocal (Gunnell et al., 2011; Mack et al., 2012; Sylvester et al., 2012). Additionally, that the relationship between MVPA and positive affect was not mediated by psychological need satisfaction is inconsistent with previous research (e.g., Mack et al., 2012). Inconsistencies noted in the literature specific to the role of psychological need fulfillment in the physical activity – well-being relationship may be linked to differences in sample characteristics, measure of physical activity and/or positive and negative affect. As such further inquiry is warranted in order to make substantial claims concerning this relationship.

Results of the serial mediation bootstrapping procedure revealed a significant total effect of MVPA on well-being when both PSC and SVS served as the outcome variable of interest, with significant direct effects present for PSC only. Examination of the specific indirect effects indicated that mediation was evident between MVPA and well-being, with increases in an omnibus index of psychological need satisfaction at each test administrations influencing psychological need satisfaction at the subsequent test administration, leading to increased well-being at the third test administration. Again, mediation was not evident between MVPA and positive affect or MPVA and negative affect. Serial mediation is present only when considering more cognitive evaluations (i.e., PSC, SVS) of well-being rather than affective well-being.

Examination of the specific paths within the serial mediation model highlights a number of key findings. While in the hypothesized direction, there was no significant relationship between MVPA and the composite measure of psychological need

satisfaction. This finding is in contrast to those emanating from the multiple mediation analyses. The lack of relationship between MVPA and psychological need satisfaction could be attributed to ceiling effects (Wang et al., 2009) as participants comprising the present sample indicated high scores on the PNSE, well-being and were sufficiently active to receive health benefits with GLTEQ scores above 14 METS (Godin, 2011). Additionally, the use of composite scores for the PNSE may contribute to the differences noted, as perceived satisfaction of the need for autonomy was associated with MVPA in the opposing direction from the other psychological needs. Further, the use of composite scores may also account for disparities in conclusions drawn concerning the mediational role of psychological need satisfaction in the MVPA – well-being relationship based on analytical strategy (i.e., multiple mediation, serial mediation). More specifically, examination of the relationship through multiple mediation (Preacher & Hayes, 2007) provided greater support for the mediating role of psychological need satisfaction. While research using composite scores on the PNSE has rarely been adopted (e.g., Hagger et al., 2006), concerns have been expressed around using aggregate scores with other SDT-based instruments (Wilson, Sabiston, Mack, & Blanchard, 2012). Wilson and colleagues (2012) compared differences in the prediction of physical activity behaviour based on three different scoring protocols from scores on the Behavioural Regulation in Exercise Questionnaire (Mullan, Markland, & Ingledew, 1997). Different scoring protocols were found to yield different results such that non-aggregated (as opposed to aggregated) scores accounted for greater variance in physical activity behaviour. Additionally, the use of non-aggregated scores allowed for more specific conclusions to be drawn concerning which type of motivation is most important to predicting behavioural

outcomes (Wilson et al., 2012). Further research into the use of composite scores for the PNSE is warranted given findings within other theories (i.e., Wilson et al., 2012).

Despite the disparities in conclusions drawn, regardless of analytical method selected psychological need satisfaction served as a mediator in the MVPA – well-being relationship, with the importance of on-going psychological need satisfaction highlighted.

### **Limitations**

While this study provides further insight into the complex relationship between MVPA, well-being, and psychological need satisfaction it is not without limitations. The present investigation utilized a homogeneous sample of young adults, and as such caution should be used when making generalizations from this research. Similarly, the use of non-probability based sampling further limited the external validity (Lucas, 2003) of conclusions drawn from this research. The results are true only for this sample, and replication in more diverse samples is required in order to determine the external validity of these results.

Study conclusions were based exclusively on self-report, a mode of data collection linked with a number of issues (Crocker & Algina, 1986). Such issues include social desirability, recall bias, and a general misunderstanding of the questions posed to the participants (Crocker & Algina, 1986). Subjective evaluations of, and affective reactions to, one's life lie at the core of well-being (Diener, 2008) and are often extrapolated through self-report measures. It is recognized that several other methods or modes of assessing well-being also have been adopted including informant reports (Schimmack, 2008), memory based measures (Seidlitz et al., 1997) and, reaction-time based 'implicit' measures (Kim, 2004). With the exception of implicit measures, self-

report measures typically correlate at least moderately with measures from each of the other assessment modalities. Collectively, this work provides evidence for the validity of self-reports of well-being.

Like well-being, physical activity is most commonly assessed via self-report and is also subject to issues such as recall bias (Welk, 2002). Despite these limitations, self-report measures are still deemed an acceptable method of collecting physical activity data (Welk, 2002), and correlations between MET scores and indices of physical fitness have been noted for the GLTEQ (Jacobs et al., 1993). Further, issues pertaining to the measurement of psychological need satisfaction in exercise contexts have been noted (Wilson et al., 2003). Although self-report will likely continue to be the dominant choice for the assessment of well-being, psychological need satisfaction and exercise behaviour, additional approaches can and should be employed in future work to validate self-report measures.

The timing of data collection, specifically the choice of a 3-week span between test administrations, could also be considered a limitation to the present investigation. Longitudinal research examining psychological needs as mediators is scarce thus far, however the research that has been conducted in this area has examined the relationship over a longer span of time (e.g., 6 months; Mack et al., 2012). While three week intervals do not allow a long span of time in which to observe change, Pedhazur and Schmelkin (1991) advocate that in order to test for stability a 1-2 week time frame must be used. As such, outside of the 1-2 week frame it is possible that change will occur. To this point, Standage and colleagues (2012) noted changes in perceived need satisfaction and physical self-concept over a period of 2-weeks. Additionally, the 3-week intervals

present a starting point within the literature, and future research is encouraged to expand upon it in order to determine if the same pattern of relationships is evident over an extended period of time.

Choices concerning analytic approaches and statistical comparisons employed were guided by the study hypotheses. Given the number of study variables a large number of statistical comparisons were performed. Consistent with statistical conventions in psychological research, an alpha level of .05 was employed for each comparison. The alpha level defines the Type I error rate (Pollard & Richardson, 1987). The odds of making a Type I error increase as a function of a number of factors, including the number of statistical comparisons computed. Given that researchers typically strive to avoid making conclusions based on 'false positive' results, it is desirable to limit the number of statistical tests computed in a given study in order to reduce Type I errors. Other approaches for reducing Type I error include lowering alpha in an effort to compensate for the number of statistical tests computed (e.g., lowering alpha to a more conservative level or a Bonferroni correction). These statistical decisions may indeed serve to attenuate the probability of making a Type I error, however they hold implications for a second type of error - Type II error (Pedhauzer & Schmelkin, 1991).

In the present investigation, it was decided not to employ an omnibus alpha correction or reduce the number of comparisons. Rather upper limits for  $p$ -values (e.g.,  $p < .05$ ,  $p < .01$ ) for individual statistical tests were interpreted where possible. Further, the bivariate correlations reflect effect sizes that offer insight into practical significance of study findings. Consistent with this approach, the magnitude of effect size was reported

as opposed to simply focusing on the statistical significance level. For the tests of mediation interpretation of confidence intervals following bootstrapping procedures, as opposed to  $p$  values, were adopted. It is believed this approach provides a reasonable compromise between using an arbitrarily adjusted alpha level (e.g., .01 instead of .05) or an overly restrictive adjusted alpha based on a Bonferroni-type correction to determine the "significance" of the findings (Preacher & Hayes, 2008). Nonetheless, it is acknowledged that the large number of statistical comparisons computed raises the probability that some of the results identified as "statistically significant" may be Type I errors.

Finally, while theory allows for a scientific and structured examination of the research question limiting the research to a single theory could neglect other potential variables. As such by selecting a different theory to guide the research, or by using a number of theories in conjunction, it may have been possible to further understand the mechanisms through which MVPA influences well-being. For example, variables embedded within Social Cognitive Theory (Bandura, 1997), such as self-efficacy, have been shown to play a role in the relationship between physical activity and well-being. It is possible that by restricting the present research to BPNT (Deci & Ryan, 2002) pertinent variables were ignored which limited the conclusions made.

### **Future Directions**

Through mediation analysis the present study provides support for the role of psychological need satisfaction in the MVPA – well-being relationship over a 6-week period, with perceived competence specifically implicated. Future research would do well to examine the relationship over a longer period of time. Replication adopting a

longer span of time between test administrations (e.g., 2-months) would provide further credence to the role of ongoing psychological need satisfaction in exercise contexts.

The present investigation provides further support to the growing body of literature documenting psychological need satisfaction as a mechanism through which MVPA influences well-being. However, the investigation into other possible mechanisms is warranted. The use of BPNT (Deci & Ryan, 2002) was adopted in part to restrict the analyses to a parsimonious number of possible mediators and not intended to be inclusive of all possible mechanisms underpinning the MVPA – well-being relationship. As Preacher and Hayes (2007) argue, there are always other possible mediators. A number of other potential mediators have been identified in the literature, and future research would do well to extend this line of inquiry to include these variables. Sheldon and colleagues (2001) contend that self-esteem may be a fourth psychological need, while Wilson and colleagues (2006) found self-actualization to be strongly correlated with well-being. Future research should endeavour to examine self-esteem and self-actualization as possible mediators of the MVPA – well-being relationship, as well as to examine other possible mechanisms.

By looking specifically at moderate and vigorous structured exercise a large portion of energy expended through the day is ignored (Bouchard et al., 2007). The present study restricted participation to those who engaged in MVPA with a GLTEQ score of 14 or greater (Godin, 2011), and ignored mild intensity activities, those engaged in for less than 15 minutes, and incidental activity. Future research may wish to extend beyond these restrictions and examine all intensities of exercise, including mild exercise. Further, leisure time physical activity is activity engaged in by personal choice during



leisure that increases energy expenditure (Bouchard et al., 2007). Future research may do well to extend beyond structured exercise and examine the nature of the relationship in those engaged more broadly in health-enhancing physical activity including energy expended during domestic and occupational activities.

Despite the fact that physical activity is most commonly assessed via self-report instrumentation there is still a lack of consensus concerning how best to measure exercise or physical activity behaviour (Welk, 2002). Future research could use more objective measures of exercise to examine the MVPA – well-being relationship. Activity monitors are one way through which the intensity of exercise behaviour may be captured. Future research may wish to utilize activity monitors, or a combination of both objective and subjective measurement, when examining the MVPA – well-being relationship.

Given that study conclusions were derived from naturally occurring changes in MVPA and well-being, the true nature of the relationship between MVPA and well-being or the influence of psychological need satisfaction may be obfuscated. Future research may wish to conduct a similar study utilizing an intervention in order to determine if manipulation of the independent variable yields a similar pattern of relationships. Further, researchers may wish to conduct an intervention in an environment that fosters participant's psychological needs for competence, autonomy, and relatedness. By doing so a greater understanding of the importance of satisfying the key psychological needs proposed by Deci and Ryan (2002) within BPNT within the exercise context to well-being may be achieved.

The present investigation contributes to previous research (e.g., Mack et al., 2012) noting that perceived autonomy is not associated with well-being in physical activity

contexts. While Deci and Ryan (2002) contend that all three needs are of equal importance there is mounting evidence to the fact that perceived competence may be the most important psychological need required to promote well-being. Future research may wish to further examine the role of autonomy and relatedness in exercise settings such that statements concerning the role of these two psychological needs can be made with greater confidence.

### **Practical Implications**

The present investigation contributed to existing literature documenting a link between MVPA and well-being. While building on previous research this investigation provides unique insight into the mechanism through which MVPA contributes to well-being. Further, this investigation contributes support for the role of exercise intensity. While the link between exercise and well-being is well documented (e.g., Edmunds et al., 2006; Wilson et al., 2006) research examining potential mediators of this relationship has been limited to health enhancing physical activity (Mack et al., 2012) or physical activity in those diagnosed with osteoporosis (Gunnell et al., 2011). The present study extends this line of inquiry and provides support for the role of psychological need satisfaction within an exercise context.

Calls for research to examine which variables mediate the MVPA – well-being relationship have been forthcoming (e.g. Netz et al., 2005). While the majority of previous research has been atheoretical (Fox, 1997) the present investigation used BPNT (Deci & Ryan, 2002) as the framework to guide the examination of this relationship. Interpretation of study findings suggests that perceived competence may serve as a mediating variable. As such, one plausible way to facilitate exercise participation in

young adults may be through the provision of opportunities for people to satisfy this need in the exercise context. It may be possible to increase perception of need fulfillment by structuring exercise settings in a manner that makes individuals feel capable. Rodgers and Loitz (2008) suggest that perceptions of competence can be fostered through clear communication, respect of the individual's attempts, and celebration of successes.

The present investigation contributes important information concerning the role of exercise intensity in the promotion of well-being. Adding to existing research demonstrating the importance of high intensity (e.g., Molina-García, et al., 2011; Sylvester et al., 2012), study findings have implications for health promoters and physical activity specialist. Given the evidence that higher intensity exercise is more strongly associated with well-being physical activity specialists would do well to incorporate moderate-to-high intensity exercise into program planning. Further, health promotion specialists may wish to focus on the importance of engaging in moderate and high intensity exercise for the promotion of well-being. However, care should be taken to ensure that exercise prescription is not all strenuous as vigorous intensity exercise has been associated with lower well-being and decreased adherence (Ekkekakis et al., 2011). Self-selection of exercise intensity has been associated with greater well-being (Ekkekakis et al., 2011) and may be one avenue through which engagement in higher intensity exercise can be achieved without negative consequences.

Overall, this study highlights the positive association between MVPA and well-being within an exercise context. Given this association, engagement in MVPA appears to be one way through which well-being may be enhanced or achieved. Results of the present investigation highlight perceived psychological need satisfaction as a mechanism

through which MVPA influences psychological well-being. Specifically, satisfaction of the need for competence appears to be of particular importance to this group of exercisers. As such, health professionals may wish to encourage participation programs where MVPA is the focus for the promotion of well-being. Contexts that provide continuing opportunity for engagement in optimally challenging tasks would be most advantageous for well-being outcomes.

### **Conclusions**

Results of the present investigation contribute support for the relationship between MVPA and psychological well-being. Further, this research contributes novel evidence that fulfillment of the three basic psychological needs may serve as mediating variables through which MVPA influences well-being. The importance of on-going psychological need satisfaction is highlighted through serial mediation analysis. Perceived satisfaction of the psychological need for competence appears to be of particular importance to young adults engaged in moderate-to-vigorous exercise. While specific effects may vary contingent on the statistical analysis utilized, psychological need satisfaction served as mediators of the MVPA – well-being relationship regardless. As such, health professionals may be most successful in promoting psychological well-being when encouraging clients to participate in moderate and high intensity exercise within a context that provides ongoing opportunities for challenge mastery. This study highlights moderate-to-strenuous exercise as one avenue through which well-being can be enhanced in young adults, with suggestions for future research put forth.

## References

- American College of Sports Medicine (2006). *ACSM's guidelines for exercise testing and prescription (7th ed.)*. Philadelphia, United States: Lippincott Williams & Wilkins.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Baumeister, R. F., Campbell, J. D., Krueger, J. I., & Vohs, K. D. (2003). Does high self-esteem cause better performance, interpersonal success, happiness, or healthier lifestyles? *Psychological Science in the Public Interest*, 4, 1- 44.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117, 497-529.
- Biddle, S. J. H., & Ekkekakis, P. (2005). Physically active lifestyles and well-being. In F. A. Huppert, B. Keveme, & N. Baylis (Eds.), *The science of well-being* (pp. 140-168). Oxford, United Kingdom: Oxford University Press.
- Bixby, W. R., Spalding, T. W., & Hatfield, B. D. (2001). Temporal dynamics and dimensional specificity of the affective response to exercise of varying intensity: differing pathways to a common outcome. *Journal of Sport and Exercise Psychology*, 23, 171-190.
- Blacklock, R. E., Rhodes, R. E., & Brown, S. G. (2007). Relationship between regular walking, physical activity and health-related quality of life. *Journal of Physical Activity & Health*, 4, 138-152.
- Borg, G. (1998). *Borg's perceived exertion and pain scales*. Human Kinetics Publishers.

- Borg, G. (1982) Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise*, 14 , 377-81.
- Bostic, T. J, McGartland Rubio, D., & Hood, M. (2000). A validation of the subjective vitality scale using structural equation modeling. *Social Indicators Research*, 52, 313-324.
- Bouchard, C., Blair, S. N., & Haskell, W. L. (2007). *Physical activity and health: Human Kinetics*, Champaign, Illinois.
- Canadian Society for Exercise Physiology (2012). *Canadian Physical Activity Guidelines*. Canadian Society for Exercise Physiology, Ottawa, ON.
- Cerin, E., Leslie, E., Sugiyama, T., & Owen, N. (2009). Associations of multiple physical activity domains with mental well-being. *Mental Health and Physical Activity*, 2, 55-64.
- Chirkov, V., Ryan, R.M., Kim, Y., & Kaplan, U. (2003). Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of Personality and Social Psychology*, 84, 97-110.
- Cohen, J. A. (1992). A power primer. *Psychology Bulletin*, 112, 155-159.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Colley, R. C., Garriguet, D., Janssen, I., Craig, J., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, 22, 7-14.

- Craft, L. L., & Landers, D. M. (1998). The effect of exercise on clinical depression and depression resulting from mental illness: A meta-analysis. *Journal of Sport & Exercise Psychology*, 20, 339-357.
- Crocker, P. R. E., Sabiston, C. M., Kowalski, K. C., McDonough, M. H., & Kowalski, N. (2006). Longitudinal assessment of the relationship between self-concept and health-related behaviour and emotion in adolescent girls. *Journal of Applied Sport Psychology*, 18, 185-200.
- Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory*. Holt, Rinehart and Winston, 6277 Sea Harbor Drive, Orlando, FL 32887.
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297-334.
- Crosby, R. A.; Kegler, M. C., DiClemente, R. J. (2002). Understanding and applying theory in health promotion practice and research. In: DiClemente, RJ., Crosby, RA.; Kegler, MC., (Eds), *Emerging theories in health promotion practice and research* (pp. 1-15). San Francisco: Jossey-Bass.
- deCharms, R. (1968). *Personal causation: The internal affective determinants of behavior*. New York, NY: Academic Press.
- Deci, E. L. & Ryan, R. M. (2011). Levels of analysis, regnant causes of behavior and well-being: The role of psychological needs. *Psychological Inquiry*, 22, 17-22.
- Deci, E. L., & Ryan, R. M. (2002). Overview of self-determination theory: An organismic dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self- determination research* (pp. 3-33). Rochester, NY: University of Rochester Press.

- Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227-268.
- Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum Press.
- Diener, E. (1984). Subjective well-being. *Psychological Bulletin*, 95, 542-575.
- Diener, E., Lucas, R., Schimmack, U., & Helliwell, J. (2009). *Well-being for public policy*. New York: Oxford University Press.
- Diener, E. (2008). Myths in the science of happiness, and directions for future research. In M. Eid & R. J. Larsen. (Eds.). *The science of subjective well-being*. (pp. 493-514). New York, NY: Guilford.
- Diener, E., Lucas, R., Schimmack, U., & Helliwell, I. (2009). *Well-being for public policy*. Oxford: Oxford University Press.
- Dishman, R. K., Hales, D. P., Pfeiffer, K.A., Felton, G., Saunders, R., Ward, D. S., Dowda, M., & Pate, R. R. (2006). Physical self-concept and self-esteem mediate cross-sectional relations of physical activity and sport participation with depression symptoms among adolescent girls. *Health Psychology*, 25, 396-407.
- Dunn, A. L., Trivedi, M. H., Kampert, J. B., Clark, C. G., & Chambliss, H. O. (2005). Exercise treatment for depression: Efficacy and dose response. *American Journal of Preventative Medicine*, 28, 1-8.
- Dunton, G. F., Schneider, M., Graham, D. J., & Cooper, D. M. (2006). Physical activity, fitness, and physical self-concept in adolescent females. *Pediatric Exercise Science*, 18, 240-251.



- Edmunds, J., Duda, J. L., & Ntoumanis, N. (2010). Psychological needs and the prediction of exercise-related cognitions and affect among an ethnically diverse cohort of adult women. *International Journal of Sport and Exercise Psychology*, 4, 446-463.
- Edmunds, J., Ntoumanis, N., & Duda, J. L. D. (2007). Adherence and well-being in overweight and obese patients referred to an exercise on prescription scheme: A self-determination theory perspective. *Psychology of Sport & Exercise*, 8, 722-740.
- Edmunds, J., Ntoumanis, N., & Duda, J. L. D. (2008). Testing a self-determination theory-based teaching style intervention in the exercise domain. *European Journal of Social Psychology*, 38, 375-388.
- Edmunds, J., Ntoumanis, N., & Duda, J. L. D. (2006). A test of self-determination theory in the exercise domain. *Journal of Applied Social Psychology*, 36, 2240-2265.
- Efron, B. (1987). Better bootstrap confidence intervals. *Journal of the American Statistical Association*, 82, 171-185.
- Efron, B., & Tibshirani, R. J. (1993). *An introduction to the bootstrap*. Boca Raton, FL: Chapman & Hall.
- Ekkekakis, P., & Backhouse, S. H. (2009). Exercise and psychological well-being. In R. Maughan (Ed.), *Olympic textbook of science in sport* (pp. 251-271). Hoboken, NJ: Wiley-Blackwell.
- Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2004). Practical markers of the transition from aerobic to anaerobic metabolism during exercise: Rationale and case for affect-based exercise prescription. *Preventive Medicine*, 38, 149-159.

- Ekkekakis, P., Parfitt, P., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities: Decennial update and progress towards a tripartite rationale for exercise intensity prescription. *Sports Medicine*, 41, 641-671.
- Ekkekakis, P., & Petruzzello, S. J. (2000). Analysis of the affect measurement conundrum in exercise psychology: I. Fundamental issues. *Psychology of Sport and Exercise*, 1(2), 71-88.
- Emmons, R. A., & McCullough, M. E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective wellbeing in daily life. *Journal of Personality and Social Psychology*, 84, 377-389.
- Fox, K.R. (1990). *The Physical Self-Perception Profile manual*. DeKalb: Northern Illinois University, Office for Health Promotion.
- Fox, K. R. (1997). The physical self and processes in self-esteem development. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 111–139). Champaign, IL: Human Kinetics.
- Fox, K. R. (2002). Self-perceptions and sport behavior. In T. Horn (Ed.), *Advances in sport psychology (2nd ed.)* (pp. 83-99). Champaign, IL: Human Kinetics.
- Fox, K. R., & Wilson, P. M. (2008). Self-perceptual systems and physical activity. In T. Horn (Ed.), *Advances in sport psychology (3rd ed., pp. 49–64)*. Champaign, IL: Human Kinetics.
- Gilmour, H. (2007). Physically active Canadians. *Health Reports* 18, 45- 65.

- Glanz, K., & Bishop, D. B. (2010). The role of behavioural science theory in development and implementation of public health interventions. *Annual Review of Public Health, 31*, 399-418.
- Glanz, K., & Rimer, B. K. (1995). *Theory at a Glance: A Guide for Health Promotion and Practice*. Washington, DC: US Dept of Health and Human Services, National Cancer Institute, National Institutes of Health.
- Glass, G., & Hopkins, K. (1996). *Statistical methods in education and psychology* (3rd ed.). Boston: Allyn and Bacon.
- Godin, G. (2011). The Godin-Shephard leisure-time physical activity questionnaire. *Health and Fitness Journal of Canada, 1*, 18-22.
- Godin, G., & Shephard, R. J. (1997). Godin Leisure-Time Exercise Questionnaire. *Medicine & Science in Sports & Exercise*, June Supplement: S36-S38.
- Godin, G., & Shephard, R. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science, 10*, 141-146.
- Grissom, R. J., & Kim, J. J. (2005). *Effect sizes for research: A broad practical approach*. Mahwah, NJ: Erlbaum.
- Gunnell, K. E., Mack, D. E., Wilson, P. M., & Adachi, J. D. (2011). Psychological needs as mediators? The relationship between leisure-time physical activity and well being in people diagnosed with osteoporosis. *Research Quarterly for Exercise & Sport, 4*, 794- 798.
- Häkkinen, A., Rinne, M., Vasankari, T., Santtilä, M., Käkkinen, K., Kyröläinen, H. (2010). Association of physical fitness with health-related quality of life in Finnish young men. *Health and Quality of Life Outcomes, 8*, 15-23.

- Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2002). The affective beneficence of vigorous exercise revisited. *British Journal of Health Psychology*, 7, 47-66.
- Hamer, M., Stamatakis, E., & Steptoe, A. (2009). Dose-response relationship between physical activity and mental health: the Scottish health survey. *British Journal of Sports Medicine*, 43, 1111-1114.
- Hawthorne, G., & Elliot, P. (2005). Imputing cross-sectional missing data: Comparison of common techniques. *Australian and New Zealand Journal of Psychiatry*, 39, 583-590.
- Hayes, A. F. (2013). *An introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Press.
- Health Canada (2013). Canadian Guidelines for Body Weight Classification in Adults. Retrieved May 8, 2013, from <http://www.hc-sc.gc.ca/fn-an/nutrition/weights-poids/guide-ld-adult/index-eng.php>.
- Huta, V. (in press). Eudaimonia. In Boniwell, I. & Davis, S. (Eds.) *Oxford Handbook of Happiness*. Retrieved May 8, 2013, from [http://veronikahuta.weebly.com/uploads/7/8/4/4/7844925/\\_huta\\_in\\_press\\_-\\_eudaimonia\\_chapter\\_in\\_oxford\\_handbook\\_of\\_happiness.pdf](http://veronikahuta.weebly.com/uploads/7/8/4/4/7844925/_huta_in_press_-_eudaimonia_chapter_in_oxford_handbook_of_happiness.pdf).
- Huta, V. & Ryan, R.M. (2010). Pursuing pleasure or virtue: The differential and overlapping well-being benefits of hedonic and eudaimonic motives. *Journal of Happiness Studies*, 11, 735-762.
- Jacobs, D. R., Ainsworth, B. E., Hartman, T. J., & Leon, A. S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise*, 25, 81-91.

- Kahneman, D., Diener, E., & Schwarz, N. (1999). *Well-being: The foundations of hedonic psychology*. New York: Russell Sage Foundation.
- Kesebir, P., & Diener, E. (2008). In pursuit of happiness: Empirical answers to philosophical questions. *Perspectives on Psychological Science*, 3, 117-125.
- Kim, D-Y. (2004). The implicit life satisfaction measure. *Asian Journal of Social Psychology*, 7, 236-262.
- Kobau, R., Sneizek, J., & Zack, M. M. (2009). *US Centers for Disease Control and Prevention's well-being initiative: An overview*. ISQOLS Conference: Measures and goals for the progress of societies, Florence, 23–24 July. Retrieved 10 July 2012 from [http://www.isqols2009.istitutodeglinnocenti.it/Content\\_en/KOBAU\\_CDC%20Well%20Being%20Initiative%20with%20cover%20page.pdf](http://www.isqols2009.istitutodeglinnocenti.it/Content_en/KOBAU_CDC%20Well%20Being%20Initiative%20with%20cover%20page.pdf)
- Leary, M. R., & Tangney, J. P. (2003). The self as an organizing construct in the behavioural and social sciences. In M. Leary and J. Tangney (Eds.), *Handbook of self and identity* (pp. 3-14). New York: Guildford Publications.
- Lucas, J. W. (2003). Theory-testing, generalization, and the problem of external validity. *Sociological Theory*, 21(3), 236-253.
- Lundqvist, C. (2011). Well-being in competitive sports—The feel-good factor? A review of conceptual considerations of well-being, *International Review of Sport and Exercise Psychology*, 1, 1-19.
- Lykken, D., & Tellegen, A. (1996). Happiness is a stochastic phenomenon. *Psychological Science*, 7, 186 - 189.
- Lyubomirsky, S., Sheldon, K. M., & Schkade, D. (2005). Pursuing happiness: The architecture of sustainable change. *Review of General Psychology*, 9, 111-131.

- Mack, D. E., Wilson, P. M., Gunnell, K. E., Gilchrist, J. D., Kowalski, K. C., & Crocker, R. R. E. (2012). Health-enhancing physical activity: Associations with markers of well-being. *Applied Psychology: Health and Well-Being*, 4, 127-150.
- Mackinnon, A., Jonn, A. F., Christensen, H., Korten, A. E., Jacomb, P. A., & Rodgers, B. (1999). A short form of the positive and negative affect schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample. *Personality & Individual Differences*, 27, 405-416.
- Marsh, H. W. (1990a). A multidimensional, hierarchical selfconcept: Theoretical and empirical justification. *Educational Psychology Review*, 2, 77-172
- Marsh, H. W. (1990b). Causal ordering of academic self-concept and academic achievement: A multiwave, longitudinal panel analysis. *Journal of Educational Psychology*, 82, 646-656.
- Marsh, H. W. (1996). Positive and negative global self-esteem: A substantive meaningful distinction or artifactors? *Journal of Personality and Social Psychology*, 70, 810-819.
- Marsh, H. W. (1997). Longitudinal study of preadolescent sport self-concept and performance: Reciprocal effects and causal ordering. *Child Development*, 78, 1640-1656.
- Marsh, H. W., Byrne, B. M., & Yeung, A.S. (1999). Causal ordering of academic self-concept and achievement: Reanalysis of a pioneering study and revised recommendations. *Educational Psychologist*, 34, 154-157.

- Marsh, H. W., Chanal, J. P., & Sarrazin, P. G. (2006). Self-belief does make a difference: A reciprocal effects model of the causal ordering of physical self-concept and gymnastics performance. *Journal of Sports Sciences, 24*, 101-111.
- Marsh, H. W., Richards, G., Johnson, S., Roche, L. A., & Tremayne, P. (1994). Physical Self-Description Questionnaire: Psychometric properties and multitrait-multimethod analysis of relations to existing instruments. *Journal of Sport and Exercise Psychology, 16*, 270-305.
- Martin Ginis, K. A., Latimer, A. E., Buchholz, A. C., Bracy, S. R., Craven, B. C., Hayes, K. C., Kicks, A. L., McColl, M. A., Potter, P. J., Smith, K., & Wolfe, D. L. (2008). Establishing evidence-based physical activity guidelines: Methods for the Study of Health and Activity in People with Spinal Cord Injury (SHAPE SCI). *Spinal Cord, 46*, 216-221.
- Martinsen, E. W. (2008). Physical activity in the prevention and treatment of anxiety and depression. *Nordic Journal of Psychiatry, 26*, 25-29.
- McAuley, E., Blissmer, B., Marquez, D. X., Jerome, G. J., Kramer, A. F., & Katula, J. (2000). Social relations, physical activity, and well-being in older adults. *Preventive medicine, 31*, 608-617.
- McCrae, R. R., & Costa, P. T. (1990). *Personality in adulthood*. New York: Guilford Press.
- McDonough, M. H. & Crocker, P. R. E. (2007). Testing self-determined motivation as a mediator of the relationship between psychological needs and effective and behavioural outcomes. *Journal of Sport & Exercise Psychology, 29*, 645-663.

- Molina-García, J., Castillo, I., & Queralta, A. (2011). Leisure-time physical activity and psychological well-being in university students. *Psychological Reports, 109*, 453-460.
- Mullan, E., Markland, D., & Ingledew, D. K. (1997). A graded conceptualisation of self-determination in the regulation of exercise behaviour: Development of a measure using confirmatory factor analytic procedures. *Personality and Individual Differences, 23*(5), 745-752.
- Netz, Y., Wu, M. J., Becker, B. J., & Tenenbaum G. (2005). Physical activity and psychological well-being in advanced age: A meta-analysis of intervention studies. *Psychology of Aging, 20*, 272-284.
- Noar, S. M., & Zimmerman, R. S. (2005). Health behaviour theory and cumulative knowledge regarding health behaviours: Are we moving in the right direction? *Health Education Research, 20*, 275-290.
- Noble, B. J., & Noble, J. M. (1998). Perceived exertion: The measurement. In J. L., Duda (Ed), *Advances in sport and exercise psychology measurement* (pp. 351-360). Morgantown, W.V.: Fitness Information Technology.
- Oztekin, C., & Tezer, E. (2009). The role of sense of coherence and physical activity in positive and negative affect of Turkish adolescents. *Adolescence, 44*, 421-432.
- Pasco, J. A., Jacka, F. N., Williams, L. J., Brenna, S. L., Leslie, E., & Berk, M. (2011). Don't worry, be active: Positive affect and habitual physical activity. *Australian and New Zealand Journal of Psychiatry, 45*, 1047-1052
- Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, Design, and Analysis: An Integrated Approach*, Erlbaum, Hillsdale, NJ.



- Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*, 189-193.
- Pollard, P., & Richardson, J. T. (1987). On the probability of making Type I errors. *Psychological Bulletin, 102*, 159-163.
- Preacher, K. J., & Hayes, A. F. (2008). Contemporary approaches to assessing mediation in communication research. In A. F. Hayes, M. S. Slater, & L. B. Snyder (Eds.), *The SAGE Sourcebook of Advanced Data Analysis Methods for Communication Research* (pp. 13-54). Thousand Oaks, CA: Sage Publications, Inc.
- Preacher, K. J., & Hayes, A. F. (2007). Contemporary approaches to assessing mediation in communication research. In A. F. Hayes, M. S. Slater, & L. B. Snyder (Eds.), *The SAGE Sourcebook of Advanced Data Analysis Methods for Communication Research* (pp. 13-54). Thousand Oaks, CA: Sage Publications, Inc.
- Pyszczynski, T., Greenberg, J., Solomon, S., Arndt, J., & Schimel, J. (2004). Why do people need self-esteem? A theoretical and empirical review. *Psychological Bulletin, 130*, 435-468.
- Rahman, R.J., Thøgersen-Ntoumanis, C., Thatcher, J., & Doust, J. (2011). Changes in need satisfaction and motivation orientation as predictors of psychological and behavioural outcomes in exercise referral. *Psychological Health, 16*, 1521-1539.
- Reed, J. & Ones, D. S. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*, 477-514.
- <http://dx.doi.org/10.1016/j.psychsport.2005.11.003>

- Reed, J. & Buck, S. (2009). The effect of regular aerobic exercise on positive-activated affect: A meta-analysis. *Psychology of Sport and Exercise*, 10(6), 581–594.  
<http://dx.doi.org/10.1016/j.psychsport.2009.05.009>
- Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality & Social Psychology Bulletin*, 26, 419-435.
- Rodgers, W. M., & Loitz, C. C. (2008). The role of motivation in behavior change: How do we encourage our clients to be active? *ACSM's Health & Fitness Journal*, 12, 7-12.
- Ryan, R.M. & Deci, E.L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology*, 52, 141-166.
- Ryan, R. M., & Frederick, C. M. (1997). On energy, personality and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality*, 65, 529-565.
- Ryff, C. D., & Singer, B. (1998). The contours of positive human health. *Psychological Inquiry*, 9, 1-28.
- Ryff, C. D., & Singer, B. (2000). Interpersonal flourishing: A positive health agenda for the new millennium. *Personality and Social Psychology Review*, 4, 30-44.
- Schimmack, U. (2008). The structure of subjective well-being. In M. Eid (Ed.) & R. J. Larsen (Ed.). *The science of subjective well-being*. (pp. 97-123). New York, NY: Guilford Press.
- Schmutte, P. S., & Ryff, C. D. (1997). Personality and well-being: Reexamining methods and meanings. *Journal of Personality and Social Psychology*, 73, 549-559.

- Seidnitz, L., Wyer, R. S., & Diener, E. (1997). Cognitive correlates of subjective wellbeing: The processing of valenced life events by happy and unhappy persons. *Journal of Research in Personality*, 31, 240-256.
- Shavelson, R. J., Hubner, J. J. & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research*, 46, 407-441.
- Sheldon, K. M., Elliot, A. J., Kim, Y., and Kasser, T. (2001). What is satisfying about satisfying events? Testing 10 candidate psychological needs. *Journal of Personality and Social Psychology*, 80, 325-339.
- Sheldon, K. M., & Lyubomirsky, S. (2004). Achieving sustainable new happiness: Prospects, practices, and prescriptions. In A. Linley & S. Joseph (Eds.), *Positive psychology in practice* (pp. 127–145). Hoboken, NJ: John Wiley & Sons.
- Solberg, P. A., Hopkins, W. G., Ommundsen, Y., & Halvari, H. (2012). Effects of three training types on vitality among older adults: A self-determination theory perspective. *Psychology of Sport and Exercise*, 13(4), 407-417.
- Standage, M., Gillison, F. B., Ntoumanis, N., & Treasure, D.C. (2012). Predicting students' physical activity and health-related well-being: A prospective cross-domain investigation of motivation across school physical education and exercise settings. *Journal of Sport and Exercise Psychology*, 34, 37-60.
- Steel, P., Schmidt, J., & Shultz, J. (2008). Refining the relationship between personality and subjective well-being. *Psychological Bulletin*, 134, 138-161.
- Swann, W. B. (1996). *Self-traps: The elusive quest for higher self-esteem*. New York: W. H. Freeman.
- Sylvester, B. D., Mack, D. E., Busseri, M. A., Wilson, P. M., & Beauchamp, M. R. (2012). Health-Enhancing Physical Activity, Psychological Needs Satisfaction,

and Well-Being: Is it how often, how long, or how much effort that matters?.

*Mental Health and Physical Activity.*

Tabacknick, B., & Fidell, L. S. (2007). *Using multivariate statistics* (5th Ed.), Needham Heights, MA: Allyn & Bacon.

Tessier, S., Vuillemin, A., Bertrais, S., Boini, S., Le Bihan, E., Oppert, J., ... Briancon, S. (2007). Association between leisure-time physical activity and health-related quality of life changes over time. *Preventative Medicine*, 44, 202-208.

Thompson, B. (2001). Significance, effect sizes, stepwise methods, and other issues: Strong arguments move the field. *Journal of Experimental Education*, 70, 80-93.

Triado, C., Viallr, F., Sole, C., & Celdran, M. (2007). Construct validity of Ryff's scale of psychological well-being in Spanish older adults. *Psychological Reports*, 100, 1151-1164.

U.S. Department of Health and Human Services (1996). Physical activity and health: A report of the surgeon general. *Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion* (pp. 278), Atlanta, GA.

U.S. Department of Health and Human Services (1999). Achieving a moderately active lifestyle, in: U.S.D.H.H.S., Public Health Service, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition and Physical Activity (Eds.), *Promoting physical activity: A guide for community action* (pp.15-37). Champaign, Illinois: Human Kinetics.

Vallerand, R. J., & Ratelle, C. F. (2002). Intrinsic and extrinsic motivation: A

- hierarchical model. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 101-121). Rochester, NY: University of Rochester Press.
- Van Ryn, M., & Heaney, C.A. (1992). What's the use of theory? *Health Education and Behavior, 19*, 315-330.
- Vansteenkiste, M., Niemiec, C., & Soenens, B. (2010). The development of the five mini-theories of self-determination theory: An historical overview, emerging trends, and future directions. In T. Urdan & S. Karabenick (Eds.). *Advances in Motivation and Achievement, vol. 16: The decade ahead* (pp. 105-166). UK: Emerald Publishing.
- Vlachopoulos, S. P., & Karavani, E. (2009). Psychological needs and subjective vitality in exercise: A cross-gender situational test of the needs universality hypothesis. *Hellenic Journal of Psychology, 6*, 207-222.
- Vlachopoulos, S. P., Ntoumanis, N., & Smith, A. L. (2010). The Basic Psychological Needs in Exercise Scale: Translation and evidence for cross-cultural validity. *International Journal of Sport and Exercise Psychology, 8*, 394-412
- Vuillemin, A., Boini, S., Bertrais, S., Tessier, S., Oppert, J., Hereberg, S., Guillemin, F., & Briancon, S. (2005). Leisure-time physical activity and health-related quality of life. *Preventative Medicine, 41*, 562 - 569.
- Wang, L., Zhang, Z., McArdle, J. J., & Salthouse, T. A. (2008). Investigating ceiling effects in longitudinal data analysis. *Multivariate behavioral research, 43*(3), 476-496.

- Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *Canadian Medical Association Journal*, 174, 801-809.
- Wendel-Vos, G. C. W., Schuit, A. J., Tijhuis, M. A. R., & Kromhout, D. (2004). Leisure-time physical activity and health-related quality of life: Cross-sectional and longitudinal associations. *Quality of Life Research*, 13, 667-677.
- White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review*, 66, 297-333.
- World Health Organization (2012). *Global recommendations on physical activity for health*. Geneva: World Health Organization.
- Wilson, P. M., & Bengoechea, E. G. (2010). The relatedness to others in physical activity scale: Evidence for structural and criterion validity. *Journal of Applied Behavioural Research*, 15, 61-87.
- Wilson, P. M., Longley, K., Muon, S., Rodgers, W. M., & Murray, T. C. (2006). Examining the contributions of perceived psychological need satisfaction to well-being in exercise. *Journal of Applied Biobehavioral Research*, 11, 243-264.
- Wilson, P. M., Mack, D. E., Blanchard, C., & Gray, C. E. (2009). The role of perceived psychological need satisfaction in exercise related affect. *Hellenic Journal of Psychology*, 6, 183-206.
- Wilson, P. M., Mack, D. E., Gunnell, K. E., Oster, K. G., & Gregson, J. P. (2008). Analyzing the measurement of psychological need satisfaction in exercise contexts: Evidence, issues and future directions. In M. P. Simmons & L. A. Foster (Eds.), *Sport and exercise psychology research advances*. Nova Science Publishers.

- Wilson, P. M., & Muon, S. (2008). Psychometric properties of the exercise identity scale in a university sample. *International Journal of Sport and Exercise Psychology*, 6, 115-131.
- Wilson, P. M., & Rodgers, W. M. (2007). Self-determination theory, exercise and wellbeing. In M. Hagger, & N Chatzisarantis (Eds.), *Intrinsic motivation and self determination in exercise and sport* (pp. 101-112). Champaign, IL: Human Kinetics.
- Wilson, P. M., Rodgers, W. M., Blanchard, C. M., & Gessell, J. (2003). The relationship between psychological needs, self-determined motivation, exercise attitudes, and physical fitness. *Journal of Applied Social Psychology*, 33, 2373-2392.
- Wilson, P. M., Rodgers, W. M., Fraser, S. N., Murray, T. C. & McIntyre, C. A. (2004). The relationship between psychological need satisfaction and self-perceptions in females. *Journal of Sport and Exercise Psychology*, 26, S200.
- Wilson, P. M., Rodgers, W. M., Loitz, C., & Scime, G. (2006). It's who I am really! The importance of integrated regulation in exercise contexts. *Journal of Applied Biobehavioral Research*, 11, 79-104.
- Wilson, P. M., Rogers, W. T., Rodgers, W. M., & Wild, T. C. (2006). The psychological need satisfaction in exercise scale. *Journal of Sport & Exercise Psychology*, 28, 231-251.
- Welk, G. J. (2002). Use of accelerometry-based activity monitors to assess physical activity. *Physical activity assessments for health-related research*, 125-141.

### Notes

1. Pearson bivariate correlations were calculated between the measure of exercise intensity adopted in the present investigation (i.e., GLTEQ MVPA scores) and the single item SWEAT index of the GLTEQ and scores from the RPE (Borg, 1982). GLTEQ MVPA scores correlated with SWEAT in the expected direction ( $r$ 's ranged from  $-.12$  to  $-.33$ ) such that greater engagement in MVPA was associated with greater frequency of sweating while exercising. Similar results were found with ratings of perceived exertion ( $r$ 's ranged from  $.15$  to  $.33$ ) indicating that greater MVPA was associated with greater exertion while exercising.



Table 1

*Time 1 Demographic Descriptive Statistics*

	Total ( <i>n</i> = 174)				Completed ( <i>n</i> = 147)				Drop-out ( <i>n</i> = 27)						
Variable	<i>M</i>	<i>SD</i>	<i>Skew.</i>	<i>Kurt.</i>	<i>M</i>	<i>SD</i>	<i>Skew.</i>	<i>Kurt.</i>	<i>M</i>	<i>SD</i>	<i>Skew.</i>	<i>Kurt.</i>	<i>t</i>	<i>p</i>	<i>d</i>
Age	20.84	1.39	1.55	3.20	20.85	1.51	1.51	2.68	20.89	1.13	.88	.63	.20	.84	.05
Height (inches)	68.40	3.83	.26	-.62	67.96	.12	-.77	1.82	69.54	4.22	.27	-.70	1.60	.11	.13
Weight (lbs)	160.88	29.70	.19	-.71	156.71	28.98	.32	-.56	166.18	31.40	-.05	-1.25	1.07	.29	.22
			%				%				%		$\chi^2$	<i>p</i>	<i>phi</i>
Gender													.36	.68	-.05
Male			45.5 ( <i>n</i> = 96)				45.9 ( <i>n</i> = 67)					53.6 ( <i>n</i> = 14)			
Female			54.5 ( <i>n</i> = 115)				55.1 ( <i>n</i> = 80)					46.4 ( <i>n</i> = 13)			
Marital Status															
Single/Never			99.5 ( <i>n</i> = 210)				100 ( <i>n</i> = 147)					100 ( <i>n</i> = 28)	--	1.00	--
Married															
Married/ Common Law			.5 ( <i>n</i> = 1)												
Ethnic Origin													.96	.62	.07
Caucasian			93.8 ( <i>n</i> = 198)				92.6 ( <i>n</i> = 136)					96.4 ( <i>n</i> = 26)			
Asian			2.4 ( <i>n</i> = 5)				3.4 ( <i>n</i> = 5)								
Other			3.8 ( <i>n</i> = 8)				4.1 ( <i>n</i> = 6)					3.6 ( <i>n</i> = 1)			

*Note.* *M* = Mean; *SD* = Standard Deviation; *Skew* = Skewness; *Kurt* = Kurtosis; For Chi-Squared analysis, not all cells have 5% or more of cases; *d* = effect size (Cohen, 1988); *phi* = phi coefficient.

Table 2

*Time 1 Study Variable Descriptive Statistics*

Variable	<i>M</i>	<i>SD</i>	Range	<i>Skew.</i>	<i>Kurt.</i>	$\alpha$
Subjective Vitality	5.14	.93	1 – 7	-.33	-.51	.84
Physical Self-Concept	4.51	1.06	1 – 6	-.76	.54	.97
Positive Affect	3.86	.63	1 – 5	-.85	2.34	.85
Negative Affect	1.52	.49	1 – 5	.92	.37	.58
PNSE Competence	5.15	.69	1 – 6	-.85	1.30	.91
PNSE Autonomy	5.38	.76	1 – 6	-1.81	4.97	.93
PNSE Relatedness	4.60	1.15	1 – 6	-1.23	.95	.95
GLTEQ METs	66.14	39.54	0 – $\infty$	3.30	16.50	---

*Note.* *N* = 147; *M* = Mean; *SD* = Standard Deviation; *Skew.* = Skewness; *Kurt.* = Kurtosis;  $\alpha$  = Cronbach's (1951) Coefficient  $\alpha$ ; PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity

Table 3

*Time 2 Study Variable Descriptive Statistics*

Variable	<i>M</i>	<i>SD</i>	Range	<i>Skew.</i>	<i>Kurt.</i>	$\alpha$
Subjective Vitality	5.17	1.04	1 – 7	-.15	-.13	.89
Physical Self-Concept	4.60	.98	1 – 6	-.71	.51	.98
Positive Affect	3.84	.63	1 – 5	-.46	-.04	.81
Negative Affect	1.50	.59	1 – 5	1.96	5.70	.75
PNSE Competence	5.23	.61	1 – 6	-.42	-.52	.91
PNSE Autonomy	5.37	.64	1 – 6	-1.41	3.74	.93
PNSE Relatedness	4.74	.98	1 – 6	-1.36	2.56	.94
GLTEQ METs	61.94	45.88	0 – $\infty$	5.88	51.67	---

*Note.* *N* = 147; *M* = Mean; *SD* = Standard Deviation; *Skew.* = Skewness; *Kurt.* = Kurtosis;  $\alpha$  = Cronbach's (1951) Coefficient  $\alpha$ ; PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity

Table 4

*Time 3 Study Variable Descriptive Statistics*

Variable	<i>M</i>	<i>SD</i>	Range	<i>Skew.</i>	<i>Kurt.</i>	$\alpha$
Subjective Vitality	5.08	1.09	1 – 7	-.50	-.05	.90
Physical Self-Concept	4.58	.95	1 – 6	-.77	.93	.98
Positive Affect	3.73	.73	1 – 5	-.60	1.10	.89
Negative Affect	1.40	.48	1 – 5	1.55	2.83	.71
PNSE Competence	5.08	.68	1 – 6	-.76	1.03	.93
PNSE Autonomy	5.23	.70	1 – 6	-.97	1.38	.95
PNSE Relatedness	4.74	1.01	1 – 6	-1.37	2.55	.96
GLTEQ METS	58.72	30.63	0 – $\infty$	1.83	5.27	---

*Note.* *N* = 147; *M* = Mean; *SD* = Standard Deviation; *Skew.* = Skewness; *Kurt.* = Kurtosis;  $\alpha$  = Cronbach's (1951) Coefficient  $\alpha$ ; PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity.

Table 5

*Pearson Bivariate Correlations between Study Variables at Time 1*

Construct	1	2	3	4	5	6	7	8
1. Subjective Vitality	--							
2. Physical Self-Concept	.31**	--						
3. Positive Affect	.63**	.29**	--					
4. Negative Affect	-.08	-.15*	-.04	--				
5. PNSE Competence	.52**	.46**	.54**	-.04	--			
6. PNSE Autonomy	.22**	.16*	.10	-.15	.26**	--		
7. PNSE Relatedness	.30**	.24**	.34**	.11	.34**	.09	--	
8. GLTEQ METs	.16*	.28**	.19*	.08	.25**	-.15*	.21**	--

*Note.* \* = Correlation is significant at the 0.05 = level (1-tailed); \*\* Correlation is significant at the 0.01 level(1-tailed); PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $N = 147$ .

Table 6

*Pearson Bivariate Correlations between Study Variables at Time 2*

Construct	1	2	3	4	5	6	7	8
1. Subjective Vitality	--							
2. Physical Self-Concept	.49**	--						
3. Positive Affect	.66**	.44**	--					
4. Negative Affect	-.12	-.13	-.11	--				
5. PNSE Competence	.51**	.53**	.51**	-.20*	--			
6. PNSE Autonomy	.24**	.29**	.30**	-.11	.52**	--		
7. PNSE Relatedness	.35**	.30**	.33**	-.02	.31**	.10	--	
8. GLTEQ METs	.26**	.23**	.29**	.03	.22**	-.05	.16*	--

*Note.* \* = Correlation is significant at the 0.05 = level (1-tailed); \*\* Correlation is significant at the 0.01 level (1-tailed); PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $N = 147$ .

Table 7

*Pearson Bivariate Correlations between Study Variables at Time 3*

Construct	1	2	3	4	5	6	7	8
1. Subjective Vitality	--							
2. Physical Self-Concept	.63**	--						
3. Positive Affect	.62**	.44**	--					
4. Negative Affect	-.20**	-.15	-.03	--				
5. PNSE Competence	.60**	.68**	.42**	-.16	--			
6. PNSE Autonomy	.43**	.44**	.28**	-.27**	.58**	--		
7. PNSE Relatedness	.44**	.33**	.45**	-.06	.33**	.25**	--	
8. GLTEQ METs	.23**	.26**	.28**	.13	.20**	-.04	.25**	--

*Note.* \* = Correlation is significant at the 0.05 = level (1-tailed); \*\* Correlation is significant at the 0.01 level (1-tailed); PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $N = 147$ .

Table 8

*Pearson Bivariate Correlations between Change Scores for Study Variables at Time 1 – Time 2*

Construct	1	2	3	4	5	6	7	8
1. $\Delta$ Subjective Vitality	--							
2. $\Delta$ Physical Self-Concept	.15 <sup>*</sup>	--						
3. $\Delta$ Positive Affect	.37 <sup>**</sup>	.16 <sup>*</sup>	--					
4. $\Delta$ Negative Affect	-.06	-.06	-.04	--				
5. $\Delta$ PNSE Competence	.24 <sup>**</sup>	.17 <sup>*</sup>	.31 <sup>**</sup>	-.22 <sup>**</sup>	--			
6. $\Delta$ PNSE Autonomy	.11	.09	.07	-.01	.33 <sup>**</sup>	--		
7. $\Delta$ PNSE Relatedness	.12	.11	.17 <sup>*</sup>	-.02	.28 <sup>**</sup>	.12	--	
8. $\Delta$ GLTEQ METs	.16 <sup>*</sup>	.15 <sup>*</sup>	.17 <sup>*</sup>	.05	.06	.04	-.04	--

*Note.*  $\Delta$  = Standardized Residuals Time 1 – Time 2; \* = Correlation is significant at the 0.05 level (1-tailed); \*\* = Correlation is significant at the 0.05 level (1-tailed); PNSE = Psychological Need Satisfaction in Exercise; GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $n = 147$ .



Table 9

*Pearson Bivariate Correlations between Change Scores for Study Variables at Time 1 – Time 3*

Construct	1	2	3	4	5	6	7	8
1. $\Delta$ Subjective Vitality	--							
2. $\Delta$ Physical Self-Concept	.36**	--						
3. $\Delta$ Positive Affect	.53**	.36**	--					
4. $\Delta$ Negative Affect	-.15*	-.06	.01	--				
5. $\Delta$ PNSE Competence	.43**	.30**	.28**	-.12	--			
6. $\Delta$ PNSE Autonomy	.28**	.25**	.17**	-.21**	.51**	--		
7. $\Delta$ PNSE Relatedness	.28**	.24**	.33**	-.07	.26**	.32**	--	
8. $\Delta$ GLTEQ METs	.11	.19**	.17*	.16*	.02	-.02	.07	--

*Note.*  $\Delta$  = Standardized Residuals Time 1 – Time 2 \* = Correlation is significant at the 0.05 level (1-tailed); \*\* = Correlation is significant at the 0.05 level (1-tailed); PNSE = Psychological Need Satisfaction in Exercise GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $n = 147$ .

Table 10

*Pearson Bivariate Correlations between Change Scores for Study Variables at Time 2 – Time 3*

Construct	1	2	3	4	5	6	7	8
1. $\Delta$ Subjective Vitality	--							
2. $\Delta$ Physical Self-Concept	.29**	--						
3. $\Delta$ Positive Affect	.45**	.31**	--					
4. $\Delta$ Negative Affect	-.19*	-.07	-.01	--				
5. $\Delta$ PNSE Competence	.37**	.33**	.20**	-.04	--			
6. $\Delta$ PNSE Autonomy	.30**	.22**	.12	-.19*	.43**	--		
7. $\Delta$ PNSE Relatedness	.29**	.15**	.36**	.01	.34**	.35**	--	
8. $\Delta$ GLTEQ METs	.11	.02	.18*	.21**	.02	-.15*	.09	--

*Note.*  $\Delta$  = Standardized Residuals Time 1 – Time 2 \* = Correlation is significant at the 0.05 level (1-tailed); \*\* = Correlation is significant at the 0.05 level (1-tailed); PNSE = Psychological Need Satisfaction in Exercise GLTEQ METs = Estimated Energy Expenditure for Moderate and Vigorous Physical Activity;  $n = 147$ .

Table 11

*Bootstrapped Indirect Effects of MVPA (Time 1) on Well- and Ill-Being (Time 2) Through Psychological Need Satisfaction (Time 1)*

Variable	Point Estimate	Bca CI	R <sup>2</sup> adj.
Subjective Vitality			.23**
Total	.003	.001 - .007	
PNSE – Competence	.003	.001 - .005	
PNSE – Autonomy	.000	-.002 - .000	
PNSE – Relatedness	.001	.000 - .003	
Physical Self-Concept			.27**
Total	.003	.001 - .006	
PNSE - Competence	.003	.001 - .006	
PNSE - Autonomy	.000	-.002 - .000	
PNSE - Relatedness	.000	.000 - .002	
Positive Affect			.24**
Total	.001	.000 - .003	
PNSE - Competence	.001	.000 - .003	
PNSE - Autonomy	-.001	-.002 - .000	
PNSE - Relatedness	.001	.000 - .002	
Negative Affect			-.02
Total	.000	-.001 - .001	
PNSE - Competence	.000	-.001 - .001	
PNSE - Autonomy	.000	.000 - .002	
PNSE - Relatedness	.000	-.001 - .001	

*Note:* PNSE = Psychological Need Satisfaction in Exercise. *Number of bootstrap resamples = 5000. Bca CI = Bias Corrected and Accelerated Confidence Intervals. \*p = .01; \*\*p = .001*

Table 12

*Bootstrapped Indirect Effects of MVPA (Time 1) on Well- and Ill-Being (Time 3) Through Psychological Need Satisfaction (Time 1)*

Variable	Point Estimate	Bca CI	R <sup>2</sup> adj.
Subjective Vitality			.23**
Total	.003	.000 - .006	
PNSE – Competence	.002	.001 - .004	
PNSE – Autonomy	.000	-.003 - .000	
PNSE – Relatedness	.001	.000 - .003	
Physical Self-Concept			.26**
Total	.003	.001 - .006	
PNSE - Competence	.003	.001 - .005	
PNSE - Autonomy	.000	-.002 - .000	
PNSE - Relatedness	.001	.000 - .002	
Positive Affect			.11**
Total	.001	.000 - .003	
PNSE - Competence	.001	.000 - .003	
PNSE - Autonomy	.000	-.002 - .000	
PNSE - Relatedness	.000	.000 - .002	
Negative Affect			-.01
Total	.000	-.001 - .001	
PNSE - Competence	.000	-.001 - .001	
PNSE - Autonomy	.000	.000 - .001	
PNSE - Relatedness	.000	-.001 - .001	

*Note:* PNSE = Psychological Need Satisfaction in Exercise. *Number of bootstrap resamples = 5000. Bca CI = Bias Corrected and Accelerated Confidence Intervals. \*p = .01; \*\*p = .001*

Table 13

*Bootstrapped Indirect Effects of MVPA (Time 2) on Well- and Ill-Being (Time 3) Through Psychological Need Satisfaction (Time 2)*

Variable	Point Estimate	Bca CI	R <sup>2</sup> adj.
Subjective Vitality			.28**
Total	.003	.000 - .006	
PNSE – Competence	.002	.000 - .004	
PNSE – Autonomy	.000	-.002 - .000	
PNSE – Relatedness	.001	.000 - .003	
Physical Self-Concept			.28**
Total	.002	.001 - .006	
PNSE - Competence	.002	.001 - .004	
PNSE - Autonomy	.000	-.001 - .000	
PNSE - Relatedness	.001	.000 - .002	
Positive Affect			.13**
Total	.001	.000 - .003	
PNSE - Competence	.001	.000 - .003	
PNSE - Autonomy	.000	-.001 - .000	
PNSE - Relatedness	.000	.000 - .002	
Negative Affect			-.01
Total	.000	-.001 - .001	
PNSE - Competence	.000	-.001 - .000	
PNSE - Autonomy	.000	.000 - .001	
PNSE - Relatedness	.000	.000 - .001	

*Note:* PNSE = Psychological Need Satisfaction in Exercise. *Number of bootstrap resamples = 5000. Bca CI = Bias Corrected and Accelerated Confidence Intervals. \*p = .01; \*\*p = .001.*

Table 14

*Path Coefficients From Models Estimated Using PROCESS*

	Physical Self-Concept	Subjective Vitality	Positive Affect	Negative Affect
<b>a1</b>	.0022	.0022	.0022	.0022
<b>a2</b>	-.0003	-.0003	-.0003	-.0003
<b>a3</b>	.0004	.0004	.0004	.0004
<b>a4</b>	.6565**	.6565**	.6565**	.6565**
<b>a5</b>	.6654**	.6654**	.6654**	.6654**
<b>b1</b>	.0188	.1528	.0670	.0677
<b>b2</b>	.2996	.1535	.0339	-.0651
<b>b3</b>	.7135**	.9922**	.4976**	-.1751
<b>c1</b>	.0050*	.0051*	.0025	.0004
<b>c1'</b>	.0036*	.0031*	.0015	.0006

*Note:* \*  $p < .05$ ; \*\*  $p < .01$



Brock University  
Research Ethics Office  
Tel: 905-688-5550 ext. 3035  
Email: reb@brocku.ca

Social Science Research Ethics Board  
Certificate of Ethics Clearance for Human Participant Research

DATE:	9/7/2012		
PRINCIPAL INVESTIGATOR:	WILSON, Philip Kinesiology		
FILE:	12-014 - WILSON		
TYPE:	Masters Thesis/Project	STUDENT:	Lindsay Meldrum
		SUPERVISOR:	Philip Wilson

TITLE: Well-Being and Exercise: A dynamic relationship?

**ETHICS CLEARANCE GRANTED**

Type of Clearance: NEW

Expiry Date: 9/30/2013

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards

and the Tri-Council Policy Statement. Clearance granted from 9/7/2012 to 9/30/2013.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before

9/30/2013. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at <http://www.brocku.ca/research/policies-and-forms/research-forms>.

In addition, throughout your research, you must report promptly to the REB:

- Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
- All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
- New information that may adversely affect the safety of the participants or the conduct of the study;
- Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

\_\_\_\_\_  
Jan Frijters, Chair  
Social Sciences Research Ethics Board

## *Appendix B: Instructor Recruitment Script*

---

The following verbal instructions represent an example of the script used to approach course instructors for access to recruit participants from their classes.

*Good Morning/Evening:*

*My name is Lindsay Meldrum and I am contacting you as a graduate student in the Faculty of Applied Health Sciences at Brock University. I am conducting research that will inform my master's thesis and help us gain a greater understanding of the relationship between exercise and well-being over time.*

*I am e-mailing you to request permission to recruit participants from your class. Understanding that your participation is completely voluntary, if you agree to aid my research, I am requesting permission to speak to your class for approximately two minutes, either at the beginning or end of class. During this time I would communicate to them the purpose and requirements of my research, and how to contact me if they are interested in participating. If you are willing to allow me to recruit from your class, please let me know a time that is convenient for you. Your endorsement is voluntary, and all information provided will remain confidential. It is not our intent to induce psychological harm upon your students through participation in this research. Please remember that this is a voluntary activity and you are free to not participate. If you have any questions please do not hesitate to ask. Thank you for your help with this project.*

Lindsay S Meldrum, BA ([lm07pa@brocku.ca](mailto:lm07pa@brocku.ca))

Philip M. Wilson, PhD ([phwilson@brocku.ca](mailto:phwilson@brocku.ca))

*Thank you for your time and effort. This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (File: 12-014)*



### Appendix C: Recruitment Script

---

The following verbal instructions represents an example of what will be used to guide the data collection and is consistent with Dillman's (2006) Tailored Design Method for participant recruitment and retention.

*Good Morning/Evening:*

*I am contacting you as a graduate student in the Faculty of Applied Health Sciences at Brock University. You are being invited to participate in this project entitled "Well-Being and Exercise: A dynamic relationship?" The project is designed to enhance our understanding about the relationship between exercise behaviour and well-being over time. Should you choose to participate, the information that you provide will inform my master's thesis and help us gain a greater understanding of the relationship between exercise and well-being. Your participation in this study will involve completing a series of questions and will take approximately 20-25 minutes of your time on each of three occasions. Your participation is voluntary and all of the information that you provide will remain confidential which means that we will not be sharing your personal information with any other person or party in such a manner that you could be identified as a consequence of participating in this project.*

*If you wish to participate, I ask that you complete a series of questions at three time points.*

*Please direct any questions or concerns to either Lindsay Meldrum ([lm07pa@brocku.ca](mailto:lm07pa@brocku.ca)) or Dr. Wilson, ([phwilson@brocku.ca](mailto:phwilson@brocku.ca)) via e-mail.*

*Thank you for your time and effort. This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (File: 12-014)*

### Appendix D: Reminder Script

---

The following is a sample draft of the type of information contained in the reminders that will be sent to each participant one week prior to the 12 week and 6 month follow up assessment. The script was designed on the basis of Dillman's (2007) recommendations for increasing participant retention in longitudinal designs.

*Dear <study participant's first name will be inserted here>*

*Thank you for participating in our research study entitled "Well-Being and Exercise: A dynamic relationship?". Your information is important to us and we appreciate your involvement in our research.*

*This e-mail/letter is simply to remind you that our study includes repeated assessments of your well-being and fitness.*

*Your follow-up appointment is scheduled on <xxxx-xxxx> between \_\_\_\_ and \_\_\_\_ (time)*

*If you have any questions, please do not hesitate to contact a member of the research team using the information outlined below. Should you need to reschedule your follow-up appointment, please contact a member of the research team identified below.*

*Kindest regards,*

Lindsay S. Meldrum, BA (lm07pa@brocku.ca)

Philip M. Wilson, PhD (phwilson@brocku.ca)

## *Appendix E: Letter of Invitation*

---

### **Brock University, Faculty of Applied Health Sciences**

#### Letter of Information

**Title of Study:** Well-Being and Exercise: A dynamic relationship?

**Principal Investigator:** Dr. Philip Wilson, Associate Professor, Dept. of Kinesiology

**Principal Student Investigator:** Lindsay Meldrum, BA., MA Candidate, Brock University

Dear Participant,

**Introduction:** The research project that you are being invited to participate in is entitled, “Well-Being and Exercise: A dynamic relationship?”. The investigators are researchers at Brock University with an interest in physical activity behaviour and well-being.

**Purpose:** The purpose of this study is to examine the dynamic relationship between exercise behaviour and well-being. Secondly, the processes through which exercise might confer well-being benefits are being investigated. Attention to this important health behaviour and its interplay with well-being are important for health promotion efforts.

**Involvement:** Your involvement would be greatly appreciated and will help to further our understanding of the relationship between exercise behaviour and well-being. Should you choose to participate, we will ask that you complete a questionnaire on three occasions which each test period separated by 3 weeks. The 54-item questionnaire is expected to take approximately 20-25 minutes to complete. One sample question is: “...I feel confident in my ability to perform exercises that personally challenge me”. Relevant demographic questions will also be queried such as age, height, and gender to ensure that the people who participate in this project are representative of Canadian undergraduate university students.

**Benefits:** There are a number of benefits associated with participating in this study. First, participation in this research study may translate into increased knowledge regarding your well-being. Second, it is likely that through participation in this research project you will become more acutely aware of your own exercise behaviours and well-being. Such information may be useful in promoting your own health and well-being. Third, information gained may benefit the larger community by providing information that will likely be used to improve the lives of university students.

**Feedback:** A written summary of our results from this study will be made available to

you at your request. Should you wish to receive a summary, please complete the Debriefing Form located at the end of the questionnaire. Our findings will also be disseminated in academic journals and conference presentations; however, the specific identity the participants in the study will not be disclosed.

**Confidentiality:** Any information that is provided from participants will be treated with confidentiality and access to all information that might identify participants will be limited to members of the research team named above. All data will be in a locked filing cabinet, accessible only to members of the research team. Consistent with guidelines that control the collection and storage of scientific information in Canada, all data collected for this study will be destroyed five years following the completion of the investigation.

**Participation:** Participation in this study is voluntary and individuals may decline answering any question(s) that you choose. There are no known psychological or physical risks associated with participation. You may choose to decline or withdraw your participation at any time throughout the course of the study. However, your participation is needed and would be appreciated as it will improve the conclusions derived from this investigation.

**Sponsorship:** The study has been reviewed and has received ethics clearance through the Research Ethics Board at Brock University (File # XX-XXX).

Thank you for your interest and involvement in this study.

Sincerely,

Lindsay Meldrum, BA.

Principal Student Investigator

E-mail: [lm07pa@brocku.ca](mailto:lm07pa@brocku.ca)

Tel: 905 688 5550 Ext. 5564

Philip Wilson, PhD

Principle Investigator

E-mail: [phwilson@brocku.ca](mailto:phwilson@brocku.ca)

Tel: 905 688 5550 Ext. 4997

This project has been reviewed and cleared by the Office of Research Services Ethics Board at Brock University (File #12-014). Any questions pertaining to your rights as a participant in research at Brock University can be directed to the Research Ethics Officer ([reb@brocku.ca](mailto:reb@brocku.ca) or 905 688 5550 ext. 3035).

## Appendix F: Questionnaires

---

*Section 1: This first part of the questionnaire is designed to describe the people participating in this study. All information received is held in confidence. Please provide your...*

1. Age Years

\_\_\_\_\_

2. Height

\_\_\_\_\_ Feet/inches OR \_\_\_\_\_ Metres

3. Weight

\_\_\_\_\_ Pounds (lbs) OR \_\_\_\_\_ Kilograms (Kgs)

4. What is your gender? ☐ Male ☐ Female

5. What is your current marital status?

☐ Married/  
Common Law      ☐ Widowed      ☐ Separated/  
Divorced      ☐ Single/  
Never married

6. How would you describe your ethnic origin?

☐ Aboriginal      ☐ Caucasian/W  
hite      ☐ Asian      ☐ Other

7. Do you currently exercise in a commercial fitness center (e.g. Goodlife, the Zone,...)?

☐ Yes ☐ No

a. If YES to the above, where do you currently exercise (e.g., the Zone)?

---

*Section 2: During a typical **7-Day period** (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write in each space the appropriate number)*

Intensity of Activity	Times Per Week
<ul style="list-style-type: none"> <li>• <b>Strenuous Exercise</b> (Heart beats rapidly)</li> </ul> <p>Examples of strenuous exercise include: heavy lifting, aerobics, fast bicycling, carrying heavy objects or groceries (25+ lbs) upstairs, shovelling snow, etc.</p>	
<ul style="list-style-type: none"> <li>• <b>Moderate Exercise</b> (Not exhausting)</li> </ul> <p>Examples of moderate exercise include: carrying light loads, bicycling at a regular pace, easy swimming, dancing, heavier house cleaning (i.e., washing windows, scrubbing floors), heavier outdoor work(digging, mowing, snowblowing), etc.</p>	
<ul style="list-style-type: none"> <li>• <b>Mild Exercise</b> (Minimal effort)</li> </ul> <p>Examples of mild exercise include: yoga, easy walking, slow dancing, fishing, bowling, golf, light housekeeping, light home repairs, light gardening, shopping, etc.</p>	

During a typical 7-day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

Often	Sometimes	Never/Rarely
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Section 3:* Please respond to the following statement by indicating generally, what is your perception of exertion when you engage in moderate to vigorous exercise. This feeling should reflect how heavy and strenuous the generally exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion. Choose the number from the scale below that best describes your typical level of exertion when you engage in moderate to vigorous exercise:

No exertion at all		Extremely light	Very Light		Light		Somewhat hard		Hard (heavy)		Very Hard		Extremely hard	Maximal
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Section 4:* Please respond to each of the following statements by indicating the degree to which the statement is true for you when you engage in moderate to vigorous exercise. Use the following scale:

	Not at all True			Somewhat true			Very True
1. I feel alive and vital.	1	2	3	4	5	6	7
2. I don't feel very energetic.	1	2	3	4	5	6	7
3. Sometimes I feel so alive I just want to burst.	1	2	3	4	5	6	7
4. I have energy and spirit.	1	2	3	4	5	6	7
5. I look forward to each	1	2	3	4	5	6	7

new day.							
6. I nearly always feel alert and awake.	1	2	3	4	5	6	7
7. I feel energized.	1	2	3	4	5	6	7

*Section 5: The following statements represent different feelings people have when they engage in exercise. Please answer the following questions by considering how you typically feel when you engage in moderate to vigorous exercise. Use the following scale:*

	False	Mostly False	More False than True	More True than False	Mostly True	True
1. I feel that I am able to complete exercises that are personally challenging.	1	2	3	4	5	6
2. I feel attached to my exercise companions because they accept me for who I am.	1	2	3	4	5	6
3. I feel like I share a common bond with people who are important to me when we do exercise together.	1	2	3	4	5	6
4. I feel confident I can do even the most challenging exercises.	1	2	3	4	5	6



5. I feel a sense of camaraderie with my exercise companions because we do physical activity for the same reasons.	1	2	3	4	5	6
6. I feel confident in my ability to perform exercises that personally challenge me.	1	2	3	4	5	6
7. I feel close to my exercise companions who appreciate how difficult physical activity can be.	1	2	3	4	5	6
8. I feel free to do exercise in my own way.	1	2	3	4	5	6
9. I feel free to make my own exercise program decisions.	1	2	3	4	5	6
10. I feel capable of completing exercises that are challenging to me.	1	2	3	4	5	6
11. I feel like I am in charge of my exercise program decisions.	1	2	3	4	5	6
12. I feel like I am capable of doing even the most challenging exercises.	1	2	3	4	5	6
13. I feel like I have a say in choosing my exercises that	1	2	3	4	5	6

I do.						
14. I feel connected to the people who I interact with while we do exercises together.	1	2	3	4	5	6
15 I feel good about the way I am able to complete challenging exercises.	1	2	3	4	5	6
16. I feel like I get along well with other people who I interact with while we do exercises together.	1	2	3	4	5	6
17. I feel free to choose which exercises I participate in.	1	2	3	4	5	6
18. I feel like I am the one who decides what exercises I do.	1	2	3	4	5	6

*Section 6: This scale contains a number of words describing different feelings and emotions. Indicate to what extent YOU generally feel this way when YOU engage in moderate to vigorous exercise. That is, how you feel on average when you exercise at a moderate to vigorous intensity.*

	1 Very slightly or not at all	2 A little	3 Moderately	4 Quite a bit	5 Extremely
1. Excited	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Enthusiastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Alert	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Inspired	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Determined	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Distressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Scared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Nervous	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Afraid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Section 7: Below are six statements with which you may agree or disagree. Using the 1-6 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 6-point scale is as follows:*

	False	Mostly False	More False than True	More True than False	Mostly True	True
1. I am satisfied with the kind of person I am physically	1	2	3	4	5	6
2. Physically, I am happy with myself	1	2	3	4	5	6
3. I feel good about the way I look and what I can do physically	1	2	3	4	5	6
4. Physically I feel good about myself	1	2	3	4	5	6
5. I feel good about who I am and what I can do physically	1	2	3	4	5	6
6. I feel good about who I am physically	1	2	3	4	5	6

Thank you for taking the time to participate in our study today. Your information is important to us.

### *Appendix G: Informed Consent*

---

**Title of Study:** Well-Being and Exercise: A dynamic relationship?

**Principal Investigator:** Dr. Philip Wilson, Associate Professor, Dept. of Kinesiology

**Principal Student Investigator:** Lindsay Meldrum, BA., MA Candidate, Brock University

You have been invited to participate in a research study. The purpose of this study is to examine the relationship between exercise behaviour and psychological well-being.

I understand that:

- I have been received and read the Letter of Information provided to me through members of the research team conducting the research.
- I understand that participation will involve completing a 54-item questionnaire that will take approximately 20-25 minutes on three occasions.
- The purpose of this study is to investigate the dynamic association of exercise behaviour and psychological well-being.
- I understand that no known psychological or physical risks are associated with participation.
- I understand that background information request the disclosure of personal information.
- I understand that there is no obligation to answer any question that I do not wish to answer.
- I understand that members of the research team have secured procedures to ensure participant confidentiality.
- I understand that personal information will not be anonymous, but will be kept strictly confidential such that all information will be stored and coded in such a way that personal identification is not possible other than by members of the research team.
- I understand that upon completion of the study, the research team will link all data I have provided to them over the course of this study. At this stage any data I have provided is no longer identifiable to anyone including

members of the research team. At this point, I understand that my data cannot be identified by any member of the research team and cannot be removed even at my request.

- I understand that all personal information will be kept strictly confidential and that all information will be assigned a unique alphanumeric code so that the name of individual participants will not be associated with my specific answers.
- I understand that my participation in this study is voluntary and that I may withdraw from the study at any time and for any reason.
- I understand that only members of the research team named above will have access to the data. Data stored in a locked office at Brock University.
- I understand that data will be destroyed five years following completion of the study.
- I understand that the results of this study will be distributed in academic journal articles and conference presentations and a summary of the results will be made available to the participants in the study.
- As indicated by my consent below, I acknowledge that I am participating freely and willingly.

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time. Please print a copy of this form for your own records.

<input type="checkbox"/>	I consent to participate in this study by checking this box	Date:	
<p>If you have any questions about this study or require further information, please contact the Principal Investigator using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (File# 12-014). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.</p>			

*Appendix H: Debriefing Form*

---

**Brock University, Faculty of Applied Health Sciences**  
Debriefing Form

If you wish to receive a summary of the major findings from this study, please provide either your mailing address or your e-mail in the space provided below:

E-mail Address: \_\_\_\_\_

OR

Mailing Address: \_\_\_\_\_

---

---

---

---

---